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THE
HOUSEHOLD PHYSICIAN

A FAMILY GUIDE TO THE PRESERVATION OF
HEALTH AND THE DOMESTIC TREATMENT OF
ILLNESS

BY

J. M'GREGOR-ROBERTSON

M.A., M.B., C.M.(Honours), F.F.P.S.G., F.R.S.(Ed.)
Formerly Lecturer on Physiology in the University of Glasgow

WITH AN INTRODUCTORY NOTE BY

JOHN G. M'KENDRICK, M.D., LL.D., F.R.S.
Emeritus Professor of the Institutes of Medicine, Glasgow University

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INTRODUCTORY NOTE

It is the object of this treatise to give such an account of diseases and of their remedies as can be readily understood by persons of ordinary education, and the author has attempted to accomplish this without the sacrifice of scientific accuracy. A simple statement of fact, and a clear exposition of fundamental principles, are perfectly compatible with a scientific treatment of any branch of learning. No doubt, certain sciences require for the statement of details the use of a language to a large extent their own, but the general conclusions even of such sciences can always be expressed in simple and familiar terms. It is a well-known fact that a master in science, he who has a comprehensive grasp both of the facts and of the principles of the science, is more likely to express himself in lucid and intelligible language than the tyro who possesses only a superficial knowledge of his subject. The gift of popular exposition—using the term popular in the best sense—is not necessarily associated with narrow knowledge and shallow thinking, but is often found in the man whose knowledge is wide and varied, and who is thoroughly conversant with the most profound problems of the science he expounds. A perusal of this work will, I believe, justify these statements.

Medicine, in the broad meaning of the term, embraces a wide range of scientific knowledge. It deals with the facts of disease, with the remedies appropriate to various diseases, with the results of accident or injury to the human body, with the causes that affect the origin and spread of diseases, and with the general laws that regulate the health of individuals and the health of communities. Primarily, it may be conveniently divided into external medicine, or surgery, and internal medicine, or medicine proper; that is to say, the diseases affecting the outer frame are relegated to the care of the surgeon, while those that affect the internal organs belong to the province of the physician. Another great department related to these two, is obstetric medicine, or midwifery, dealing with the natural process of child-bearing and with the diseases peculiar to women. Closely connected with this is the department that comprehends the diseases of children. Finally, there are departments dealing with special organs, such as those relating to diseases of the eye, diseases of the ear, diseases of the throat, diseases of the skin, &c. &c., each of which occupies its own domain of knowledge, and is represented by highly-trained specialists.

Medicine, however, is not only a department of science comprehending an immense number of facts, nor is it merely a statement of general principles, but it is an art in which practical skill is brought to bear on the detection and the treatment of disease. This is, of course, the aspect of medicine which is of practical importance to the great majority of persons. When a man is suffering from a disease or from the effects of an injury, he desires to be relieved of pain, to have the disease cured, or to have the injury properly treated by the surgeon, and the scientific aspects of medicine or of surgery are of no great importance to the patient; indeed, he may be of opinion that the less he knows of such matters the better. A great deal can be said in justification of this frame of mind, which is not peculiar to the ignorant, but is to be met with also among the learned, and even in members of the medical profession. It is often argued that in the province of medicine, if in any, the trite maxim holds good, that a little knowledge is dangerous, more dangerous, some would say, than no knowledge at all; that a man can no more be expected to be in any sense his own doctor than he can hope to be successfully his own lawyer; and that the knowledge required by a doctor for the successful exercise of his profession is of such a technical kind that a person of ordinary education can scarcely hope to comprehend it. Surely, it may be said, if the training of a medical man is so elaborate and costly, involving five or six years of study in the class-room, the laboratory, and the hospital, it is not to be expected that outsiders can acquire by a little reading any knowledge of medicine that will be of service to them in daily life. It may be at once conceded that, as regards the more complex diseases, there is some truth in this argument; but, at the same time, when applied to medicine in general, it arises from a partial and imperfect view of the question, and it is an opinion rapidly disappearing before the march of intellectual progress. Medicine is neither more nor less than a branch of natural science. Its facts are of the same nature, and are as easy of comprehension, as those of chemistry, or physics, or botany, or geography. It contains no secrets, no occult mysteries to be divulged only to the initiated; and those who practise it lay no claim to any knowledge but that which may be acquired by observation and patient study. The science of medicine is simply the application of common sense to the explanation of the facts of disease. It is the attempt to see things as they really are, without any glamour of the mystery that is always associated with imperfect knowledge. Such a work as the present, therefore, will not only guide the reader to the diagnosis and the treatment of the simpler forms of disease, and be of great service in circumstances where it is impossible to obtain skilled medical aid, but it will also diffuse intelligent ideas regarding the nature and treatment of the more serious diseases where medical aid is necessary. The physician is not unfrequently thwarted in his efforts by the ignorance or erroneous views of patients and of their attendants. Hence an acquisition of the information contained in the following pages, by raising the level of general intelligence, cannot fail in being of the greatest practical service.

Much of the misunderstanding that prevails in the minds of even thoughtful people regarding medicine has arisen from an erroneous view of the nature of disease, and of how much treatment may be expected to accomplish; and not a little quackery, and an inclination to have faith in the nostrums of quacks, can be traced to the same cause. In common with other phenomena, diseases were at first invariably traced to supernatural causes. They were held to be proofs of the direct agency of unseen beings, or of an unseen being. Such a view, of course, associated the treatment of diseases with the special ministers of these unseen powers, and the disease, supposed to be due to the influence of demons or malignant spirits, was exorcised by ceremonies, often of a cruel character, and by prayers and adjurations. In course of time it was gradually recognized that diseases were natural phenomena, but they were then endowed with a personality, and the disease was held to be a principle or entity distinct from its effects. It has required centuries to eradicate this notion from the minds of even the learned, while it still holds its ground, especially among the unlearned, in the thoughts and language of everyday life. Thus the bronchitis, the measles, the cancer, the erysipelas, are still, to many, things, agencies, entities, that have a real existence, abounding here and there, and ready to pounce on the unfortunate being who comes under their malign influence. It followed from this view, that if these diseases are things that somehow get into the body, they must be driven out by strong and urgent measures. The enemy must be compelled to evacuate the citadel of life, even although the citadel itself should be destroyed in the process. Hence the application of violent remedies — bleeding, blistering, purging, &c.—that not unfrequently sapped the very foundations of vitality.

A more rational view now prevails among educated persons, and there can be no doubt that such a treatise as the present will implant and confirm it among those who, by education and habits of thought, are still disposed to entertain the older notions. It is to be regretted, however, that even among intelligent persons the old erroneous views are still to be met with, and nothing is more surprising to a medical man than to find, as he frequently does, a man of strong practical common sense, a man of wide information and shrewd in the ways of the world, a prey to illiterate quacks who impose on his credulity by professing their readiness to give him a specific potion for every ailment and a balm for every sore. Such a man craves for a specific remedy. He has a notion that the disease from which he suffers is a thing for which there must be a specific remedy—not a remedy merely for a symptom, not something that will only relieve pain or promote healing, but something that will actually *cure* the disease. Such views have also led to the adoption of various systems of treatment. One school holds that only vegetable remedies are appropriate to the treatment of disease, taking a narrow view of the opinions of the old friar who thus soliloquizes:—

> "I must up-fill this osier-cage of ours
> With baleful weeds, and precious-juiced flowers.
> . . . . . .
> Many for many virtues excellent,
> None but for some, and yet all different.
> O mickle is the powerful grace that lies
> In herbs, plants, stones, and their true qualities:
> . . . . . .
> Within the infant rind of this small flower
> Poison hath residence, and medicine power;
> For this, being smelt, with that part cheers each part;
> Being tasted, slays all senses with the heart."
>
> —*Romeo and Juliet*, act ii. scene 3.

Another school upholds the virtues of the bath, in one or other of its forms, as a universal panacea for all human ills. A third maintains the universal application of the homeopathic principle of "*similia similibus curantur*", "similars are cured by similars"—that is to say, diseases are cured by substances having, in small doses, an action on the body *similar* to that of the disease: so that one may treat diseases by a series of fixed and specific formulæ, all depending on this single principle. Finally, even in orthodox medical circles, there is far too strong a disposition to attribute success in treatment to the virtues of particular drugs, and some would even assert that ordinary practitioners of medicine, or, as they are sometimes termed, allopaths, simply act on a principle contrary to that of homeopathy, namely, that diseases are cured by contraries, that is, by remedies having an action on the body the *reverse* of that of the disease.

All these extreme and erroneous opinions depend on a mistaken view of the true nature of disease. Disease is the condition parallel to that of health. Now, health is the condition brought about by the natural performance of all the functions of the body, and anything that interferes with the due performance of any one of these functions is a cause of disease. If we represented health by a straight line, disease is a deflection or bending away of this line. To vary the figure, if we suppose a complicated mechanism like a watch, working efficiently so as to keep accurate time, and with no perceptible disturbance of the play of its various wheels and pinions and chain and spring, we might say that was a condition of perfect health; but if we suppose the watch losing time from too great friction, or from the spring being too weak, or from the teeth of the pinions being worn or broken, then we might call that condition one of disease. This is of course an imperfect analogy, because the human body is infinitely more complicated than a watch; but it is a correct analogy. Anything that interferes with the free and healthy action of the parts of the body, especially as regards its minute parts—parts to be seen only with the microscope, produces a state of disease, and the symptoms of the disturbance manifest the disease. Thus various diseases are caused by the entrance into the body of living germs which grow and multiply in the blood and tissues, and interfere with the healthy action of the various organs. Such germs, by their presence, cause disturbances that are shown by the symptoms of such diseases as scarlet fever, whooping-cough, erysipelas, &c. Thus there is the high temperature, the congestion and pain in the throat, the eruption on the skin, and such symptoms as headache, sickness, delirium, due to interference with the functions of the nervous system. But the germs are not the disease, but the cause of the disease. By the disease we mean the general phenomena seen in the body and experienced in the sensations of the patient. Again, take any disease of the nervous system. A man is stricken with an apoplexy, and we find he has lost the power of one side of his body. This is not due to something that has entered the body from the outside, but to the breaking down of a certain part of his nervous system. The long strain of years of labour has led to changes in the tissues forming his blood-vessels and his brain, and these changes have been slowly taking place for years before the structure gave way. Thus the disease in this case is due to changes in tissues, and these changes in time cause a part of the bodily mechanism to give way, with the result of the production of the paralysis and of other signs and symptoms. It is clear, therefore, that no specific remedies can be applied to such diseases, and that there is no principle like that of *similia similibus curantur* of universal application.

The true physician has no specific to suggest. His object is to restore as far as possible the conditions of healthy action; to remove, if he can, the causes of the disease; to relieve pain; and to control symptoms so as to direct them toward recovery.

The true physician does not say: "Here is an infallible specific for scarlet fever;" but he moderates the fever by encouraging the action of the skin, he relieves as far as possible the pain and swelling in the throat, he moderates the action of the heart by the skilful use of remedies that restrain the bounding pulse, and he watches for and averts the complications of disorder of the kidneys that may occur, especially during the convalescence of the patient. Again, in the treatment of inflammation of the lungs, he does not profess to have a heroic treatment, such as that of profuse blood-letting, as a sure method of cutting short the disease; but he watches the symptoms, favours expectoration, moderates the pulse, and, above all, supports the patient's strength by the skilful use of nutritive fluids or stimulants. Lastly, the surgeon of the present day has no remedy for cancer. He recognizes that its remarkable characteristic is rapidity of growth, so that it invades neighbouring organs, and that it often breaks down the general health by incessant pain. Hence he advises early removal by the knife, the relief of suffering by the careful use of medicines which allay pain, and the support of the general health by nutritive and easily-digested food. These illustrations show the present stand-point of a rational physician or surgeon, and they are to be commended to the attention of intelligent members of the general public.

The method of this book illustrates the rational view of disease and of treatment that I have endeavoured to explain. If disease is merely a disturbance of the natural functions of the body, it follows that an intelligent knowledge of these functions must first be attained. This leads to a discussion of the structure of the body and of the functions of its various tissues and organs, or, in other words, there must be a basis of anatomical and physiological knowledge. Next comes the pathology, as it is termed, of the disease, that is to say, the nature of diseased processes as distinguished from those occurring in health, and here the author, in many places, illustrates the well-known fact that many diseased processes are only modifications of natural processes. Many diseases are abnormal examples of healthy processes, processes occurring at the wrong time, in the wrong place, or to too great or too little an extent. After a careful description of the general symptoms of the disease, by which it may be detected and discriminated from other diseases, the nature of remedies must next be discussed. The author here applies the important principle that the physiological action of drugs is the guide to their action in disease, that is to say, we must first determine what is the action of the drug in health, upon the heart, circulation, respiration, brain, &c., before we can rationally employ it in the treatment of disease. At the same time, it must not be forgotten that it is just this department of medicine which is wanting in precision, and which requires much extension. Many remedies are still employed because they have been found by experience to be useful, without any theory as to their mode of action. The author has made skilful use of such remedies, indicating the empirical facts that show their value.

There is no doubt a large amount of scepticism regarding the value of medicines, more especially in the medical profession itself. This arises from the difficulty often experienced of ascertaining with accuracy whether or not the apparent cure has been the result of the action of a particular drug. Many elements may contribute to a patient's recovery in addition to the special action of the medicines given by the physician. Diet, rest, careful nursing, cleanliness, the natural constitution of the patient, and his mental condition all exert an influence, and the recovery is the outcome of a number of conditions. With this knowledge, an honest physician often hesitates in giving the credit to the drugs employed. At the same time, experience has abundantly shown that drugs, judiciously used, are often of great value, and at all events materially contribute to the causes of recovery; and we may reasonably expect that as knowledge of their action on the body in health and in disease advances, the physician will be furnished with more and more trustworthy substances by which he can aid in the recovery of his patient. These views also point to the immense importance of regimen and diet in the treatment of disease.

The author has treated very fully the general conditions of personal and public hygiene, and he has discussed in the light of modern researches the influence of minute living organisms in the production of disease. Probably there is no chapter in modern medicine of greater importance than this, in which many diseases have been traced to the action of minute germs, microscopic organisms, which, finding their way into the blood and tissues, set up changes therein that are often incompatible with life. The life-history of such organisms in connection with the phenomena of fermentation and putrefaction has in recent years been carefully investigated, and the author has skilfully placed the results before his readers. It is not too much to say that whilst we may be alarmed by the thought that many virulent diseases are thus caused by invisible foes, the outlook is very hopeful, because a knowledge of the habits, mode of development, and general life-history of these minute organisms will guide the sanitary physician towards the adoption of measures by which outbreaks of such diseases may become almost impossible.

The author explains, in a separate introduction, how the stores of information in this book may be made practically available. My belief is, that while it inculcates the employment in all serious cases of medical assistance when that can be procured, and while it lends no countenance to anyone arrogating to himself the duties of the skilful physician or surgeon, it presents a fair and intelligible view of medical science, and cannot fail in diffusing valuable information regarding one of the most important departments of knowledge. A careful perusal of these pages will not puff up anyone with vain conceit, but will rather lead him to clothe himself with the garb of humility and to maintain an attitude of reverence in the presence of the vast body of knowledge laid before him. All that extensive knowledge and a singular faculty of lucid description can do to make the work interesting and instructive has been accomplished by its author.

INTRODUCTION

An Attempt to Explain in Clear Language what "Health" is, and how "Disease" differs from it; with an Account of Modern Methods employed in the Detection and Treatment of Disease.

"Will you describe to me, in a few plain words, what you mean by 'Disease'? To-day I feel well, to-morrow I, the same man, feel ill; what has made the difference? What does 'Health' itself mean, I want to know? Can't you doctors explain these things in words simple enough for any ordinary person to understand?"

This is a kind of talk with which medical men are familiar, and the persons who use it are mostly unreasonable, for they will not, as a rule, take the time or the trouble to try to understand, however plainly the explanation be given. They want a whole science, and one of the most difficult of sciences, boiled down into half a dozen sentences, and they want to understand it without the trouble of thinking. Yet these same persons would never think of button-holing a ship-builder and asking him, in a few plain words, to explain the construction of a battle-ship, though the elaborate mechanism of a battle-ship is less complicated than that of the human body.

Nevertheless we accept the challenge, and are willing to explain, in plain language, though it cannot be done in a few words, what "health" means and what "disease" is. But we are entitled to ask our questioner to sit down and use his brains, and because we are to use plain language our words must be many rather than few, for technical words are short cuts, and if we are not permitted to use them, we must go round about in the endeavour to substitute simple ones.

But if our questioner will read with patience, and will not grow weary with repetitions, we shall undertake to guide him to the comprehension he seeks. For we must guide him along a pathway every step of which is probably strange to him, and he must be content to go along it step by step. He must not grow impatient, and think he may hurry here, and skip a bit there, for if the road over which we shall lead him is to be made quite plain to him, we must often make him look back to familiarize him with it.

It is not easy to explain in general non-technical language the purpose of the various organs of the body, or to give a general idea of the way in which these organs are related to one another. Yet such a general idea would be valuable, and ought to be of interest to every person of ordinary intelligence.

In any case it seems necessary to attempt such an explanation, since most men and women, who think at all of their bodily mechanism, will attempt to form some notion of these things, which is certain to be of a very crude kind, if they have no assistance in the effort.

Let us try to build up the idea bit by bit.

A man lifts a ball in the hollow of his hand. Stripped of all but essentials, this is an illustration of a lever-action, in which two long bones and one muscle take part. The bones are that of the upper arm and one of the two forearm bones, and the muscle is the biceps. The two bones are connected at the elbow-joint, where they form a hinge; the upper end of the muscle is attached at the upper end of the arm bone and the lower end to the forearm bone. When the muscle contracts it shortens, and, the upper end being fixed, it pulls up the bone of the forearm, so that the hand with the ball in it is raised. Expressed mechanically this is a lever of the third order, in which the power (the muscle) is applied between the fulcrum (the elbow-joint) and the weight (the hand with the ball). It seems a very simple thing, yet the proper understanding of all it involves will carry with it a very fair conception of the whole of the bodily machine.

Let it be noted, first of all, that there are in the human body several hundred muscles, each of them attached at one extremity to a bone, which acts as a fixed point, and at the other extremity to another bone, free to move, the two bones being connected at a joint.

Each of these muscles may move singly; more often several muscles move together in a group; and single muscles and groups of muscles may be associated in complex movements in various ways. Think how large a part the mere mechanical movement of muscles plays in the working lives of some people. When a man stands erect he does so by the action of muscles and groups of muscles, one group bracing back his knees, others holding his trunk erect upon the legs, one set pulling in one direction, another set holding taut to prevent jerks and over-action, one set nicely balancing the other set, and all continually adjusting the amount of pull and strain to meet the tendency to sway. When the man walks, the pull of one group of muscles throws the weight of the body on one leg, which the muscles brace up to receive, and while the other muscles of that leg pull the body slightly over, the muscles of the other leg lift it, let it swing forward, and plant the foot on the ground, that leg being now braced up in turn to receive the weight from the other; all the while other groups are keeping the head and trunk erect and probably moving the arms in unison and balance with the rest of the body.

Reduced to its simplest elements all this complicated series of movements is nothing more than a series of lever actions comparable precisely to the single illustration with which we began.

Now think of a dock labourer, a coal porter, or a hod-carrier; how little is there in their working lives beyond routine mechanical movements of this kind? Or consider the stone-mason, who stands for hours chiselling at a block of stone; and think how little is going on in his body beyond the comparatively small movements of a few sets of muscles in the left arm and in the hand which

PLATE I

TO ILLUSTRATE THE STORY OF A MUSCLE IN ACTION

In the upper part of Plate I is shown an outline of shoulder, arm, and hand, the hand holding a ball, and the elements of the mechanics of the action of lifting the ball.

The **Power** (P) is supplied by the contraction of the Biceps muscle, attached to the shoulder by two heads and fixed below to the radius, or outer forearm bone. The **Weight** (W) is in the hand, and the **Fulcrum** (F) is at the elbow-joint. The order of levers to which this belongs is shown below the hand, the Power (P) being applied between fulcrum and weight—a lever of the 3rd order (see p. 2).

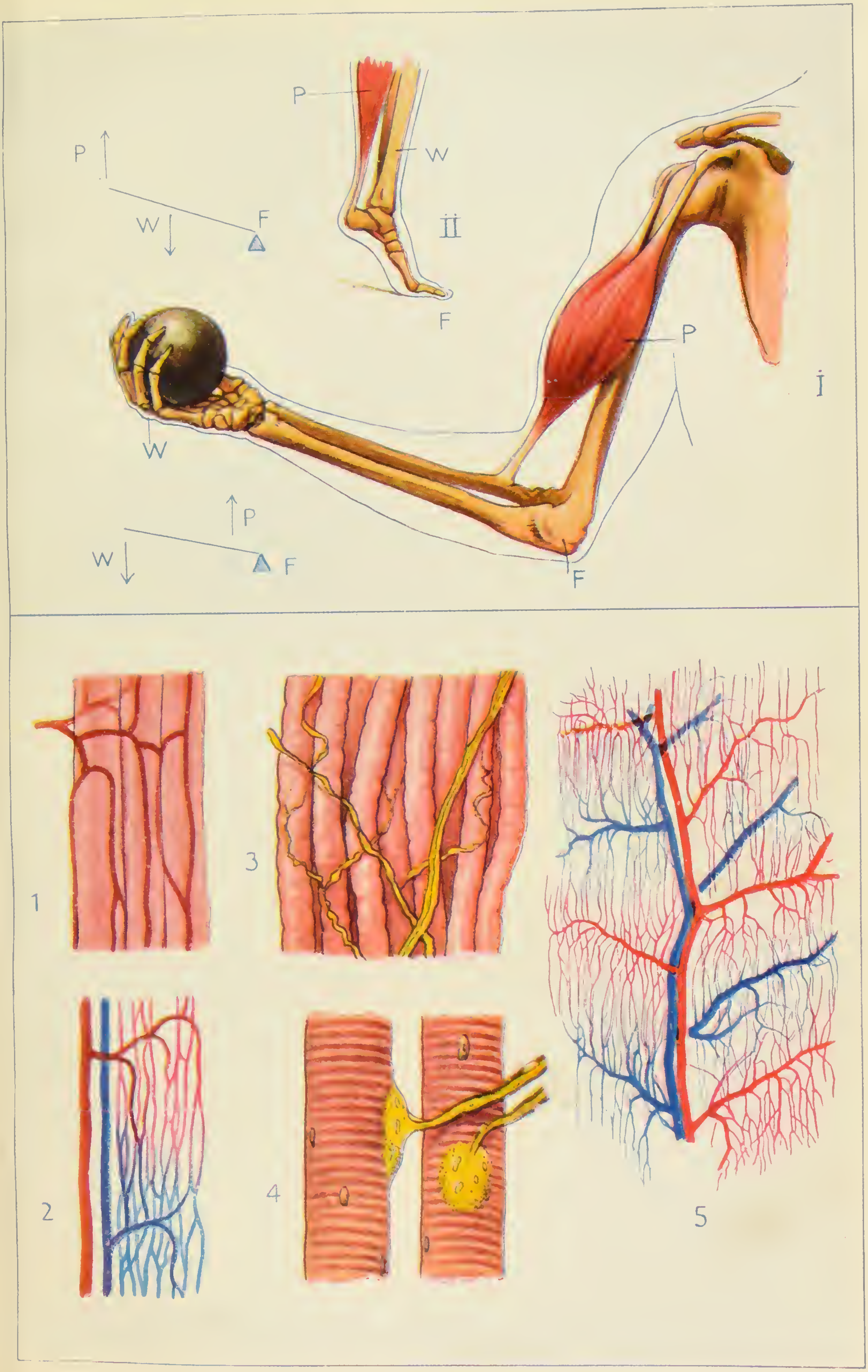
Above the hand, II is an illustration of a lever of the 2nd order, where the weight (W) is applied between the fulcrum (F) and the power (P); and an example is given in standing on tiptoe, where the power is supplied by the great calf muscle, the weight between transmitted down the bones of the leg (see p. 125).

The lower part of the plate illustrates microscopical details of the structure of muscle.

1. Three muscle fibres highly magnified, with blood-vessels which have been filled with red colouring-matter to show their arrangement (see p. 7)
2. Diagrammatic representation of blood-vessels of muscle, much less magnified than 1, arteries filled with red and veins with blue colouring-matter.
3. Highly-magnified muscle fibres, with their nerve fibres coloured yellow (see p. 10).
4. Two very highly-magnified muscle fibres, showing the mode of nerve ending in yellow.
5. Muscle with injected blood-vessels, low magnification.

PLATE I

TO ILLUSTRATE THE STORY OF A MUSCLE IN ACTION



holds the chisel, and those others of the right hand and arm which grasp, and, monotonously and automatically as it seems, raise and bring down the mallet upon the chisel.

The work done by muscles may be expressed mechanically, just as may the work done by an engine of any kind. For instance, one expresses the power of a crane by stating the amount it can lift and the height to which it can raise it, and one measures work done in this way in foot-pounds, foot-hundredweights, or foot-tons, that is, so many pounds, hundredweights, or tons lifted so many feet. The power of the biceps may be expressed in a similar way. In a man of average height and strength it is calculated that the biceps and another muscle associated with it can support a weight in the hand of 25 pounds. The extent to which, in such a case, these muscles are capable of shortening is 2 inches, and in so shortening they cause the hand to be raised 20 inches, so that in this case, neglecting (for simplicity's sake) the weight of forearm and hand, 25 pounds are lifted 20 inches, that is, these two muscles alone have a power equal to 45 foot-pounds.

If, now, one considers the case of a man of 10 stone weight walking up a stair of 60 steps, of 6 inches each, the work done by the muscles and groups of muscles, acting on bones in the way described so as to produce the movements necessary to achieve this result, would amount to 4200 foot-pounds. Elsewhere (Vol. II. p. 214) the calculation is made that a man of 150 pounds weight, by walking 1 mile, expends energy equal to lifting $17\frac{7}{10}$ tons 1 foot high. The energy expended by such a man in a 17-mile walk on a level road would be sufficient for the performance, by manual labour, of a fair day's work. Now, so far as this 17-mile walk is concerned, or this example of a fair day's work, it is almost wholly performed by the actions of muscles connected with bones in the same way as the biceps, which we began with as an illustration; and all that this fair day's work represents may, so far as essentials go, be compressed into the single action of the biceps muscle in raising the forearm and lifting a weight. To say which is just to repeat, in other words, what has been already said, that a proper understanding of all that is involved in the action of the biceps upon the forearm will carry with it a very fair conception of the whole of the bodily mechanism.

Let us unfold, then, the story of a muscle in action, remembering, as we go, that we thereby find the clue to the complex association of organs that form the living body.

The Story of a Muscle in Action.

In the first place we may note that a muscle cannot go on lifting and letting go, contracting and relaxing, indefinitely. Sooner or later its movement will become slower and weaker till it stops. If there is an interval between each movement, the muscle will go on for a much longer time than it would if one movement followed another without pause. But, sooner or later, its movements, if the interval between them be relatively small, will become feebler till they stop. After a rest of some duration, they can be again resumed, and continued again for another period till another rest is needed, and so on. What is the explanation of this? "The muscle becomes tired", is an answer easy to make; just as the whole man himself (the assemblage of muscles, so to speak) becomes tired after a day's constant work, and needs a night's rest to make him fit for another day, so each single muscle needs a period of rest to restore it after a term of activity. But what is the meaning of this enfeeblement after a period of continuous work? and what happens in the muscle during the period of rest to enable it to resume? To say the muscle becomes "tired", to say that after a period of doing nothing it becomes "rested", is to use words merely. What do these words cover? What process do they conceal? What is going on within the muscle of which the gradual enfeeblement and final stoppage are merely the evidences? and what goes on during the rest to place the muscle in a position to resume? These are the things one wishes to know.

If, in the living human body, one could isolate one muscle, say the biceps, with its attachment to the forearm, and concentrate one's attention upon it alone, keeping it steadily at work lifting, time after time, a definite weight in the hand, and watching it carefully in a variety of ways by scientific methods, one would be able, by and by, to give a scientific explanation of fatigue and recuperation after rest. An experiment of such a kind cannot be made in the human subject, but it can easily be done in cold-blooded animals. For instance, from the body of the newly-killed frog a single muscle can be removed with its bony attachments; one end is fixed in a clamp, the other end is connected to a miniature scale-pan (Fig. 1). By comparatively simple means the muscle can be made to shorten itself at regular intervals; weights are put in the pan; the height to which the pan is raised each time the muscle contracts is noted. So the work done by the muscle may be measured. The expert physiologist is able to amplify and elaborate this method of observation, and, while making his observations on a single isolated muscle, to make them as nearly as possible under conditions resembling those which normally exist in the living animal. There are various indirect ways of applying the facts so learned to the human being, and of discovering how far they are true for the human being also. If, then, we go on to unfold the history of what happens in the biceps of a man, when by its movement he lifts a weight held in his hand, one is not to be understood as giving a mere fanciful account of what is supposed to be a likely explanation. On the contrary, an account is being given of what is known to occur, the knowledge of which has been gradually worked out by an infinite variety of methods, carefully pieced together, and tested and verified in innumerable ways.

One might compare what is happening in a muscle, when it regularly contracts and does work by lifting a weight, to what is happening in a magazine rifle, fully loaded, which is being steadily fired. Each time the trigger is pressed a cartridge is exploded, the gunpowder is fired, and its compressed energy liberated, which drives the bullet to its mark. With the recoil, the empty cartridge-case is ejected from the breech, a fresh cartridge drops in from the magazine, a touch of the trigger drives another bullet to its mark, and so on till the magazine is empty. Then there is a pause to permit a fresh series of cartridges to be fitted into the magazine, and the firing is resumed. After a time the weapon becomes foul, and would refuse to work properly. To prevent this happening, at certain intervals the firing is stopped, the weapon cleaned and oiled, the magazine again loaded, and the firing resumed. One would not apply to the rifle the terms one applies to the muscle, and say the rifle becomes tired and needs a rest, one says, instead, the magazine is empty and needs refilling, and the rifle is foul and needs cleaning; but in all essentials the rifle and the muscle are perfectly comparable, and the explanation of the fact that the muscle will act best if a certain interval is allowed to occur between each movement, and if, after a certain amount of work, a prolonged rest occurs, is almost identical with the explanation of the fact that a rifle must not be fired too rapidly, and that every now and again a longer pause must ensue to permit of thorough cleaning.

Now a rifle can be fitted into a closed chamber, arrangements can be made to measure the velocity with which the bullet leaves the muzzle and to measure the energy with which it strikes the target, the gases liberated by the explosion of the powder can be collected and analysed, the fouling can be carefully removed from the weapon and weighed and analysed, and the amount by which the rifle-barrel is heated can be measured. And when all these things have been accurately done, and put together, the amount of gunpowder used and its composition can be calculated. In these days of scientific gunnery these things are constantly done. It is by means of facts so obtained that ammunition is made up for various purposes, that the sizes and weights of various weapons are settled, the amount of charge necessary ascertained, the weights of projectiles determined, the distance they will fire estimated, and their striking value calculated. To the gunnery expert you put the problem: a certain gun is required to fire a projectile of a certain weight to a certain distance, and to strike, when it gets there, with a certain force, what charge of gunpowder is required for the purpose? He will take his ascertained facts and work you out an accurate answer.

Although the precision and accuracy obtained in dealing with dead matter and dead chemical substances is not possible in dealing with living structures, nevertheless the expert physiologist can, to a certain extent, by the application of kindred methods, calculate the amount of energy required to be liberated by a muscle to lift a certain weight a given height, to accomplish, that is, a certain amount of work. For, when a muscle moves or contracts, and thereby, through the medium of bone and joint, lifts a weight, something happens quite comparable to what occurs when the trigger of a rifle is pulled and a bullet is sent on its way. If you like to make the resemblance more externally complete, instead of the hand lifting the ball, one may speak of the hand hurling the ball, as the cricketer does, through space to the wickets. In the latter case it is simply a different set of muscles that is set in motion, but the process is the same.

In the rifle a complex chemical compound is, by explosion, suddenly broken down. It is transformed into other substances, mainly gases, which, accumulating behind the bullet and expanding with great energy, drive it out of the rifle with a certain velocity. In the muscle something occurs which plays the part of the touch upon the trigger, and certain highly complex substances in the muscle break down, by which energy is liberated and the action of the muscle follows.

What evidences are there of these things? Precisely similar evidences to those obtainable from the rifle, though requiring much more delicate methods of determination. For one thing, the rifle grows warm, and the heat generated by a contracting muscle can easily be detected and measured. For another thing, as has been said, the gases given off from a fired rifle can be collected and analysed. In the case of a rifle, of course, the gases can easily be collected apart from the rifle, but in the case of a muscle the gases and other substances produced by the action of the muscle are within the muscle itself, and not so easily distinguished and separated from its own substance. But take a muscle which has been at rest for a long time, chemically analyse it, then take another which has been made to work for some time and analyse it; the composition of the one is markedly different from that of the other. Take a third muscle, which, after prolonged work, has under proper conditions been allowed time to rest and recuperate, its composition has again returned to that of the resting muscle.

In short, the muscle, which has been worked and then allowed to rest till it is fit to work again, is like the rifle which has been fired and then cleaned and reloaded, ready for another turn of firing.

Again take the rifle loaded, ready to fire, weigh it, fire it, and then reweigh it. It will be found lighter, and if the weight of the discharged bullet be subtracted, and conditions necessary to secure accuracy be observed, the amount of exploded powder may be calculated. Similarly the expert physiologist, following methods of much greater delicacy, may compare the weight of a muscle which has been at rest with the weight of a muscle that has been kept at work, and may obtain comparable results. So that the expert in one department can produce evidence as conclusive, in its way, as the expert in the other department, to show (1) that, when a muscle contracts and so lifts a weight, some complex substance within the muscle has broken down to yield the energy required to do the work, (2) that this breaking-down process is, broadly speaking, though less energetic and violent, of the same character as the explosive breaking-down of the complex substance—gunpowder—in the rifle, (3) that with each contraction of the muscle this modified explosion is repeated, and (4) that, as in the rifle, this process may be repeated till all the explosive material is used up, or till the muscle has become so loaded with the substances produced by the breaking-down process that it cannot go on till they are removed, just as in the rifle firing may cease either because the magazine is empty or because the rifle has become too foul and hot, or partly because of both, and (5) that, under proper conditions, a muscle becomes fit to resume work because new explosive material has been formed in it, and because the substances produced by its action have been partly or wholly removed.

Just as a man, firing as fast as he can pull the trigger and refill his magazine, will speedily make his weapon so hot and foul that it becomes impossible to go on—and his ammunition besides becomes speedily exhausted—so a muscle will be able to go on for a very much longer time if the rate of its work permits the formation of new explosive material within it to keep pace with the breaking down, and the removal from it of the waste products formed by its working to keep pace with their formation.

Two facts thus emerge for further explanation. The contraction or shortening of a muscle is the external evidence of some change that has occurred within the muscle, due to some complex substance breaking down within the muscle, liberating energy, and incidentally producing less complex substances of no further use in the muscle. The two facts are: (1) that a complex substance has been used up, and (2) that other substances have been produced requiring removal, and two questions necessarily follow. The first is, How are fresh supplies of explosive substance obtained? and the second is, How are the waste substances removed? Still to use the language of the rifle, How is fresh ammunition obtained? and how is the fouling removed?

Elsewhere (p. 110) the structure of muscle is described in detail, and Plate I shows a small fragment of muscle highly magnified. The figure shows that it is composed of cross-marked fibres. Between the fibres, which measure about $\frac{1}{500}$th of an inch across, there run tiny thin-walled vessels containing blood, and these vessels constantly communicate with one another by cross branches, forming a long-meshed net-work, the fibres occupying the meshes. A delicate supporting and packing tissue binds fibres and vessels together into a fleshy, shapely mass. Thus every part of a muscle is in practically direct contact with a blood-channel. The exquisitely thin wall of the vessel is no barrier to the muscle substance being bathed by the blood in it. It is from the blood-supply thus laving it that the muscle derives the material for the manufacture of fresh explosive substance. **The muscle itself, by its own vitality, manufactures its own explosive material on the spot.** This is indeed the reason for the blood-channel being in such intimate relationship with the structural elements of the muscle.

It will at once be apparent that, if the blood-vessel were a mere stagnant canal, the activity of the muscle would soon rob the blood of all the material convertible into explosive substance. **Therefore the blood is in motion,** flowing in a steady stream along the muscular fibres, constantly bathing it with fresh supplies of raw material. This is true of all the muscles of the body. It becomes evident, then, that there must be provided some mechanism fitted to drive the blood from some central source to and through every muscle of the body, and it becomes also evident that from the central source there must issue large trunks or pipes, from which, ultimately, branch pipes are given off to each muscle, and that when a branch reaches a muscle it must give off smaller branches, which finally split up into the tiny canals distributed through the muscle and among the fibres. It must be equally clear that this central source and the branches issuing from it must be connected up to form a circulatory arrangement, so that the blood, driven from the central source and distributed through all the muscles, comes back again to the centre to be redistributed as before.

Thus, then, the need of the muscle for fresh supplies of explosive substance is met by **the provision of a fluid—the blood**—containing within it the raw material for the manufacture of this substance; and the constant need for the renewal of this supply of raw material is met by **the provision of a circulatory mechanism, the organs of the circulation, the heart and blood-vessels.** If this has been properly understood, it will hardly need to be explained that each muscle will require two sets of vessels, one set consisting of one or more branches of the main trunk, bringing the blood to the muscle, which ultimately break up into the tiny channels mentioned. But these tiny channels must reunite till one or more branches are formed and issue from the muscle, by which the blood is carried back to the centre, joining up as they go with branches from other muscles till they form one or two large trunks rejoining the central source, the heart. Neither will it require much reasoning to perceive that it will be better if this central source is two-sided; the main trunk which issues from it, whose branches carry the blood to the muscles, springing from one side, while the large trunks that bring the blood back are connected to the other side, some kind of communication existing between the two sides to permit the returning blood to reach again the side from which it is reissued. The trunks and branches that distribute the blood to the muscles are called **arteries**, and those that bring it back are called **veins.** Lastly, in this connection it will be clear that the central source—the heart—must be endowed with some sort of pumping action, driving the blood out at one side, sucking it in, so to speak, by the other.

Is our promise, then, that the story of a muscle in action will afford a clue to the complex association of organs that form the living body not being redeemed? and have we not shown that the need of muscle for fresh supplies of explosive substances creates a demand which is met by—

(1) **a current of raw material,**
and (2) **a mechanism to distribute it.**

The first question, then, is answered; what about the second, the removal of the waste substances produced by the muscle's action? Any countryman could answer it. Does a stream, which flows along a field, not at one and the same time water the field and afford a channel into which the field may drain? So does the blood-stream act towards the muscle-fibre. It bathes it with fresh supplies of raw material, and it is a convenient channel into which the waste substances produced in the muscle may be washed. This is another cogent reason why the blood-stream should not be stagnant. It is not only being robbed by abstraction of raw material, it is being polluted by the addition of waste. If it were to become markedly slowed in its flow, how soon would its sluggishness become evidenced by enfeeblement of muscular action! But, for the removal of waste, the muscle is not wholly dependent upon the blood-vessels. There are other channels running in the delicate supporting tissue of the muscle, specially for the purpose of draining off the waste materials of the muscle. We might speak of them as resembling the agricultural drains of cultivated land, which carry off the superfluous water from the field, conveying it sooner or later into the main stream. These channels are called in the body **lymphatics**, and drain off, faster than the unaided blood-vessels could accomplish it, the superfluous material from the muscle. The drained-off material is ultimately returned to the blood, but not before it has passed through glands and has undergone some chemical change.

Now if it be true, as we have said, that every contraction of a muscle is accompanied by chemical changes within it, by the breaking down of complex substances into simpler ones, if it be true that the muscle manufactures fresh supplies of complex material from the blood brought to it by the artery, and if it be true that the waste products so produced are in part at least carried off from the muscle by the vein, then the blood which reaches a muscle by the artery must differ materially from the blood which leaves the muscle by the vein. Experiment shows this to be the fact. If a muscle is at rest, and has been for some time, there is, as one would expect, very little difference between the blood as it passes into, and as it passes out of, the muscle. But, if the muscle be set to work, marked differences appear, just such differences as reason would lead us to expect. The blood entering by the artery contains some substances in greater quantity than the blood leaving by the vein, while the blood leaving by the vein contains other materials not so abundant in that entering by the artery. In other words, the blood leaving by the vein is the same blood which entered by the artery, with something removed from it and other things added to it, and if the muscle has worked moderately hard the difference is obvious to the eye, for the venous blood is darker, and it can also be shown to be warmer. These are conclusive evidences of the chemical changes spoken of as accompanying and causing the liberation of energy in the muscle.

Now just think what the cumulative effect upon the blood must be if a considerable number of muscles in the body are kept steadily at work for hours on end, as in the 17-mile walk referred to, with its liberation of 300 foot-tons of energy, derived from the breaking down of complex substances in the muscle, for the replenishment of which the blood affords the raw material, and what condition must the blood be in, having washed into it the waste-products of all that broken-down material. A little while ago we were faced with the double problem, whence does the muscle obtain fresh supplies of explosive substance, and how does it get rid of its waste? And we found the answer to both parts of the problem to be the same; the blood streaming through the muscle affords the raw material for fresh explosive substance, and carries off the waste. But, it appears, we have only changed the locality of the problem, which now is: How does the blood itself get replenished, and by what means is it itself purified from the waste cast into it?

It is clear that to the bodily machine, the idea of which we are building up bit by bit, we must add two fresh pieces of mechanism, one piece which shall be devoted to the preparation and pouring into the blood of fresh supplies of material to take the place of that removed by the muscles, and another piece, or pieces, of mechanism whose business shall be the separation and removal from the blood of the waste materials cast into it. Just as we found that the need of muscle for fresh explosive substance created the demand for a stream of raw material, and an elaborate pumping apparatus to circulate it, so now we find the same need creates a demand for two separate chemical establishments,

> one of which shall be engaged in the manufacture of suitable material to replenish the blood,
> and the other of which shall be a blood-purifying works.

The former includes the elaborate set of organs, classed under the head of digestive system, and the latter another as elaborate set termed organs of excretion.

In short, the teeth, salivary glands, gullet, stomach, intestinal canal, liver, and a variety of other structures, the details of which are mentioned elsewhere, are simply parts of an intricate mechanism for the reception and chemical treatment of food-stuffs to extract from them suitable additions to be poured into the circulating stream of raw material, out of which the muscle obtains the ingredients for the manufacture of its explosive substance.

But the waste substances produced by muscle are various: some are gaseous, some are liquid, some are solid. They must all be removed from the blood into which they have been thrown. One organ can hardly deal with them all; so one set of organs, the lungs, are provided to remove the gaseous waste substances, and another set, the kidneys and skin, are arranged to deal with the liquid and solid waste substances; and at some part or other of its flow through the body, either on its outward journey from the heart or on its return thither, the blood passes through one or other of these organs and unloads itself of one or other impurity.

We began with a single muscle attached to two bones, shortening itself and so lifting a weight. What an elaborate mechanism we find is necessary to keep it at work! And all the various parts of this complicated mechanism must be properly linked up, related to one another accurately, and must be stowed away into limited space, and so arranged that adequate protection from injury shall be afforded, the most vital parts being the most deeply seated, and surrounded and supported to some extent at least by bony casing.

One important thing yet remains to be noticed. We compared a muscle to a rifle. The explosion in a rifle is set off by a touch on the trigger. What is the trigger to the muscle? How is its going off regulated? Plate I. shows another element in the structure of a muscle we have not yet noted. The part marked 4 in the lower half shows a fibre coloured yellow reaching and ending by a peculiar expansion in a muscle fibre. This yellow-coloured fibre is a nerve fibre, and, traced back, it will be found to be a branch from a bundle (3 of Plate) containing numerous fibres, each of which terminates in a muscle fibre. Each muscular mass, then, or separate muscle, which, as we have seen, consists of multitudinous muscle fibres held together by fine packing material in which the vessels already noted are distributed—each separate muscle has one or more nerve bundles connected with it, each of the nerve fibres running in the bundle being destined ultimately to end in a muscular fibre.

Now, as we have seen, in a cold-blooded animal the muscle, with its bony attachments, may be rapidly cut out of the newly killed animal, and suspended in a clamp, and still retain its vitality for a season. A length of its attached nerve may also be removed with it. The calf-muscle of the frog, with the sciatic nerve connected to it, lends itself very readily to this treatment If the loose end of the nerve be gently pinched, or irritated by a feeble electrical current, some change is produced in the still living nerve which is propagated to the muscle, and the muscle contracts. If a thread be passed round the nerve near the loose end, say at *a*, and the thread be then tied round the nerve tightly enough to destroy the structural integrity of the bundle, the muscle will give twitch after twitch during the process of tightening the thread, but will thereafter become quiescent. A pinch of the loose extremity of the nerve will no longer produce a muscular contraction, but a pinch of the uninjured bit of nerve on the muscle side of *a*, say at *b*, will evoke muscular response as before. The vital continuity of the nerve, that is to say, has been broken by the knotted thread at *a*, and the change produced at the loose end by pinching cannot pass across the break to reach the muscle, while a pinch on the muscle side of the knot produces a change which has still an uninterrupted path to the muscle. **The impulse, then, which sets off the explosive substance of the muscle reaches it along the nerve pathway.** This also is true of every one of the numerous muscles of the body.

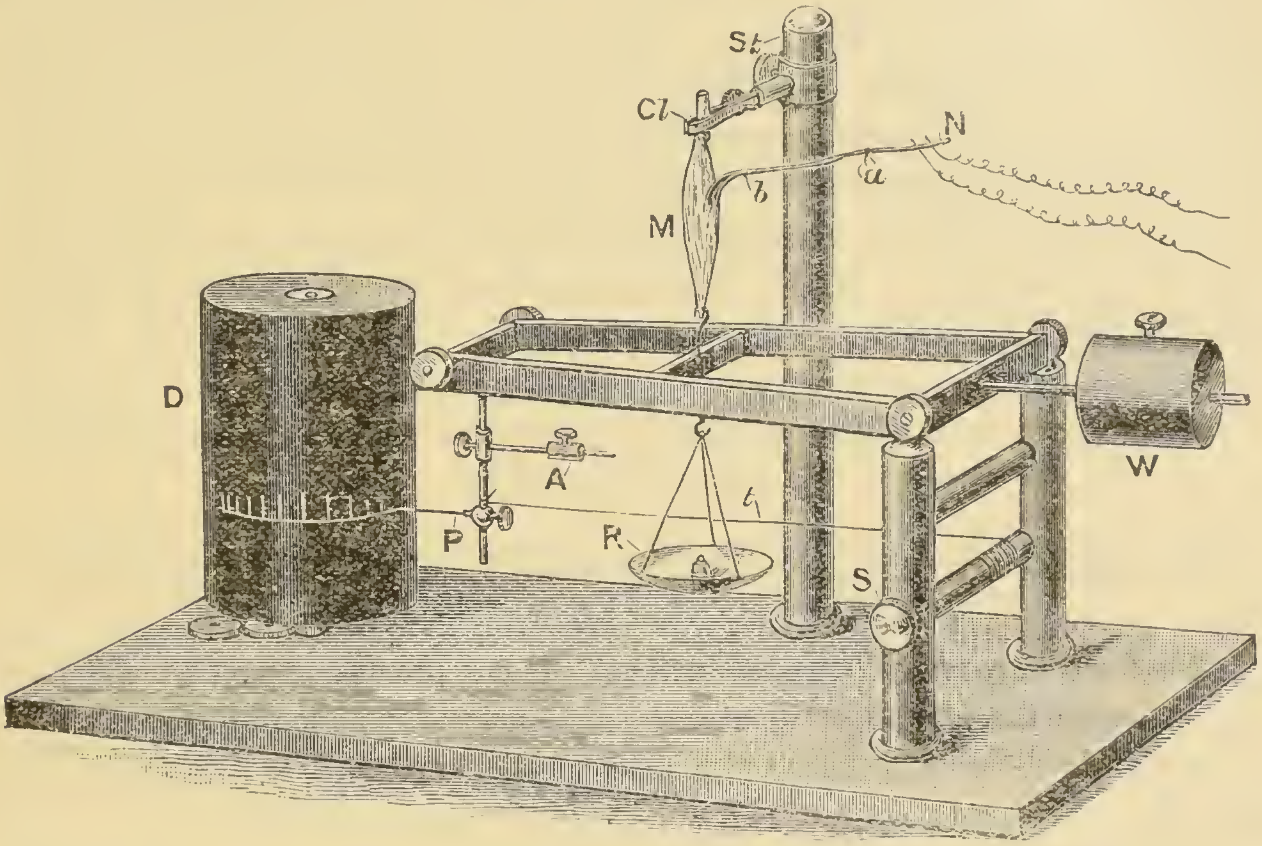


Fig. 1.—M, Calf muscle of frog, with its connected nerve, N, fixed in clamp, *Cl*, of stand, *St*. The muscle is attached below by hook to the bar arrangement carrying a scale-pan, into which varying weights, R, may be placed. This bar arrangement is counterpoised by the weight, W. A pointer, P, counterpoised by A is regulated by a thread, *t*, controlled by a screw, S, just to touch the drum, D, which is blackened by smoke. When the muscle contracts, the pointer is lifted and makes a mark on the cylinder. A heavier weight may then be put in the pan, the drum moved round to a fresh place, and the muscle made to contract again by stimulating the nerve by an electric current along the wires. So a tracing is obtained of the height the pointer is lifted by successive contractions.

Indeed it can be proved in a variety of ways that no movement of muscle occurs in the body except as the result of an impulse reaching the muscle along the nervous pathway. The nerve impulse is to the muscle what touching the trigger is to the rifle.

If, however, muscles are to act singly, and in groups, and in series of groups, to produce regulated and associated movements, as in those of standing, walking, lifting a weight, or chiselling a stone, it is obvious that all the nerves passing to all the different muscles must be connected up in some way, must arise from a common centre, where the impulses are generated and distributed in orderly fashion by the appropriate branches to the various muscles concerned in the associated movements. But this is another mechanism, completely different from that which distributes to the muscle its supply of raw material, or from that which chemically prepares its raw material, or from that which rids the stream of raw material of the impurities cast into it from the working muscle, but it is a mechanism as essential to the proper working of the muscle as any. Thus to the conception of the human body we have already formed must be added the idea of

a central controlling and regulating mechanism, the central nervous system

with numerous nerve bundles proceeding from it and distributed throughout the body.

Need we elaborate the matter further? Is our promise not redeemed? Have we not shown that the story of even a single muscle in action, if properly understood, affords the clue to the complex association of organs that form the living body?

We have seen that to keep the muscle at work

(1) A supply of raw material is needed—the blood;
(2) A mechanism to keep it in movement—the heart and blood-vessels;
(3) Another to prepare fresh supplies—the digestive organs;
(4) Another to keep it free of impurities—the lungs, kidneys, skin, &c.;
(5) Another to regulate and control its working—the nervous system.

In the evolution of this story we may have seemed to suggest that the human body was only an elaborate mechanism for the performance of physical work, for the performance of manual labour. Let us not be misunderstood. We have confined our view to this aspect of the human body merely for the sake of simplicity. The idea of physical work is so simple and familiar, and the muscular mechanism of the body forms so large a proportion of its bulk, that the idea presents less initial difficulty and can be illustrated in more concrete ways. But we might have begun with the idea of the human body as the abode of intelligence. But intelligence is an attribute of mind, and mind, in our human experience, has as its material basis the brain, the most highly elaborated portion of the central nervous system. The brain is an association of nerve cells and fibres, supported by a delicate connective tissue, and richly supplied with blood-vessels. As we have shown that the working of muscle is accompanied by chemical changes within the material substance of the muscle, so it can be shown the operations of brain are accompanied by kindred chemical changes in the material of the nervous structure, requiring raw material for its renovation, which is brought to it by blood-vessels, and attended by the production of waste which must be removed, and so the same story is repeated.

If it were necessary to continue the story, we would find that the association of organs, the need and reason for which have been set forth, exists in an external world where there is much to harm and even destroy, and where multitudinous kindred organizations exist. So our conception would require further elaboration to provide some means whereby the already complicated human mechanism can receive impressions from this external world if only to enable it to avoid the harmful and preserve its integrity, and some means whereby it may enter into relations with its kind. This involves the complex mechanism of the senses. But sufficient has been said for our present purpose.

Now just think how, in the most dull-witted, least intelligent specimen of the human race, one whose whole life is little more than a monotonous routine of the simplest physical tasks, all this elaborate association of organs is necessary for the maintenance of life and capacity to work.

How the Story of a Muscle in Action Explains what the word "Health" means and what "Disease" is.

So now we may return to the questions with which this introduction opened. What is "health"? and what is the meaning of "disease"? The human body is not a haphazard collection of parts, but an extremely intricate association of organs, each one of which has a definite part to perform, which it alone can perform, in the securing of a definite end, the performance of work of one kind or another. The task each organ discharges is related to the nature and amount of this work the body as a whole has to do. There is not much apparent kinship between a stoker and a piece of fine silk; but if the stoker's business be to charge the furnace which raises the steam to drive the mill which weaves the silk, the kinship is very near. And as the turning out, day after day, year in, year out, of properly finished bales of fine goods in a silk factory means the association of many hands in the boiler-shed, in the weaving-shed, in the dye-house, in the finishing-room, in the packing-room, and so on, so the performance, day in, day out, of work by the human body, whether manual work or intellectual labour, means the association of many organs, doing each its own part in the bodily economy, and doing it so that it properly fits in, as to time and amount, with that of the other organs.

Health, then, is that condition of the bodily machine in which all the various organs are acting together to secure, without strain or effort in any one of them, the steady and methodical performance of the work required.

Suppose, again, as we did at the beginning, that the work is manual, muscular work, then in this condition of health the chemical changes are occurring in the muscles concerned to the extent, and with the rapidity, required to cause the movements of muscle needed, the blood is streaming through the acting muscles at the increased pace necessary to renew the muscle substance undergoing change and to remove the waste produced, the heart is beating at the rate and with the strength requisite to maintain this stream, the movements of breathing are quickened that they may overtake their task of expelling the gaseous waste, the kidneys are active in their special cleansing operations, the skin is glowing with its efforts in the same direction, while unseen nervous impulses, quicker than the electric shock, are flying unfelt hither and thither, quickening one process, slowing another, and maintaining the regularity and co-operation of all. All this time, so sweetly do these elaborate mechanisms work into one another's hands, the conscious man himself, whose bodily machinery is thus busy, is so little aware of effort or strain that he is whistling a tune or humming the latest music-hall ditty.

This is "health".

But how numerous are the chances of disorder! Suppose this man, whose occupation is manual labour, is a stone-mason, or a carpenter, or an iron-worker, and suppose one morning he comes accidentally, with force, against a piece of furniture or the corner of a door with his right arm, or suppose, in a friendly scrimmage with a neighbour, he has received a blow on his arm. The force of the blow has broken several of the tiny canals that carry the blood to the muscular fibres of his biceps, and the blood has poured-out in and among the fibres, breaking up some of them, clotting and pressing upon others, the evidences of which are plain in the swelling and hardness of the part and the blue marks upon the skin. How is this muscle as a working machine thrown into disorder! The blood still comes to the muscle by its main branch, but it can no longer flow through the whole muscle as before, for some of the channels are broken, and many are blocked with the poured-out blood which has congealed. For a time a bit of the muscle, larger or smaller according to the extent of the injury, is thrown out of gear, and the muscle as a whole rendered unable to contract, or able only with difficulty and pain, till repair is effected by means we need not stop now to consider.

This is "disease".

It is, however, only local disease, limited only to a small part, and not necessarily affecting any other part of the body.

Or suppose, again, that a blow has been accidentally received from a pointed instrument, which has pierced the skin, and, doing little other damage, has chanced to cut through one of the main bundles of nerve fibres. The muscle or muscles, to which the fibres of this nerve are distributed, no longer receive the nerve impulses which should reach them along the nerve fibre. But it is only by these impulses that the muscle, as we have seen, is set in action; without them it remains motionless. This wound, then, which externally may appear of the most trifling character, causes what is called paralysis—paralysis of one or many muscles, according to the size of the nerve bundle cut,—and the person is unable to do some particular movement or other, or the whole arm is powerless and limp, and will remain so unless a surgeon cuts down on the divided nerve, before it has undergone wasting, and carefully reunites by stitches the divided ends. This, again, is an illustration of a purely local affection, which does not affect the body as a whole. But let us suppose, again, the case of men on a voyage in a sailing ship which has been dismasted in a storm, and whose rudder has been carried away, and which is drifting helplessly, out of the usual track. Supplies run short, fresh meat and vegetables speedily run out; what happens? Every one of the crew becomes bodily weakened, because the stream of blood, from which the muscles should receive the raw material for their recuperation, becomes itself impoverished, and every muscle of the body becomes unable to perform its work with its wonted rapidity and energy, because it is not getting the raw material for the renewal of its substance. The men become enfeebled, listless, and finally barely able even to move themselves about. But more than this, the blood not only brings material to the muscles for their restoration, but it does the same office to every organ of the body, and every organ therefore suffers and becomes unfit. Inasmuch, also, as the provision becomes not only lessened in quantity, but is deficient in variety, and lacking therefore in certain elements needed for a proper blood-supply more than in others, the blood becomes not only generally impoverished, but chemically altered, and this shows itself in various other ways, producing, in addition to general enfeeblement, that special form of disease called scurvy.

Here is a disease due primarily to the digestive mechanism not preparing suitable material to keep up the quality of the blood, failing to do so because that mechanism is not receiving food-stuffs sufficient in amount or of a proper kind, out of which alone the digestive apparatus can prepare suitable additions to the blood. This is an illustration of a disease not limited to a part, but affecting every portion of the body—a general disease, that is to say.

These are comparatively simple illustrations, and they could be multiplied indefinitely. But they are of themselves sufficient to illustrate in how many ways, simple or roundabout, any one of the elaborate mechanisms of the body may, by failing to do its duty, upset the general well-being of the whole machine, and so create a state of disease.

Disease, then, is a condition affecting a part only of the body, or the whole of it more or less, due to some flaw, or failure, or disturbance, or interference in one or other of the mechanisms of the body, which sooner or later makes itself felt in the working of a part or of the whole of the body.

"The Detection of Disease."

Contemplate now the task that is set any man whose business it is to discover the flaw that occasions the condition we call disease in a human body.

A man walks into a physician's study, and after the exchange of the usual civilities he states his errand somewhat thus: "Doctor, I want you to give me a tonic to set me up! I have no appetite; I am not sleeping well; I am easily tired; I hate my work; and my friends tell me I am looking ill and am nervous and irritable. I am sure all I need is a good strong tonic; now will you just write me a prescription for a good one. I am sure that is all I need." What a preposterous request! Imagine a man who owned, let us say, a small steam-launch, or a motor-car, or even only the humble universal cycle, which had begun to go badly, to work stiffly, or to lose speed, or to go by fits and starts —imagine such a man going to an engineer and saying: "Look here, this machine of mine isn't going well; it's hard to drive; I can't get the speed out of it I used to; it goes jerkily; give me a bottle of some lubricating fluid or stuff of that sort to put it right. I am sure that is all it needs." Why, even the woman who owns only a sewing-machine that slips stitches, or a typewriter that cannot spell, knows better than that. He and she alike know that if the machine, whatever it be, be put into the hands of a proper mechanic, he may be able right away to put his finger on the fault and correct it equally quickly, or he may have to go over the whole machine patiently, examining bit after bit methodically, to find perhaps that little is needed beyond loosening a screw here and tightening another there, or perhaps that one bit is worn out and needs renewal, or another has become twisted and needs straightening. But no one doubts that, if the machine is to be put into really good working condition again, all its working parts should be carefully examined, both as to their actual state of tear and wear and as to the way in which they are fitting the other parts, and the more intricate and delicate the machine the more careful and detailed must be the investigation. Why, then, should the physician, who deals with a more intricate and delicate machine than any of these, be supposed to be able to tell right off, or with one or two only of the most superficial observations, what is the nature of the fault in the ailing bodily machine?

Some diseases, it is true, to the eye of the experienced observer, declare themselves at a glance. Plate II. gives an illustration of one of these, an uncommon and remarkable affection called Myxœdema, whose features are yet so pronounced that in its fully developed form one glance is sufficient to the expert. The peculiar heaviness and coarseness of the face, the dirty yellowness of the rough, dry skin, the scanty dry hair, with patches of dry yellowish scurf on the scalp, and, when the patient speaks, the slipshod articulation and thick voice, all proclaim the general disorder from which the patient suffers. Plate II. illustrates on one side the same patient before treatment, and on the other side, a few months after treatment, when he has been restored more nearly to his usual appearance, and when his scalp is covered with a new growth of hair.

But in an immense number of cases the determination of the nature of the disorder demands methodical and patient investigation into the mode of working of each of the intricate mechanisms that are associated in the body. Often all the assistance a patient can give in this investigation is of the most vague and general character. He knows he is not well; it is the physician's business to find out where the mischief has its beginning.

How should he proceed? Any ordinarily intelligent person who has followed, with understanding, this somewhat lengthy introduction should be able to answer in a general way. He will perceive at once how valuable it would be, seeing that it is the blood streaming through them from which all the

PLATE II

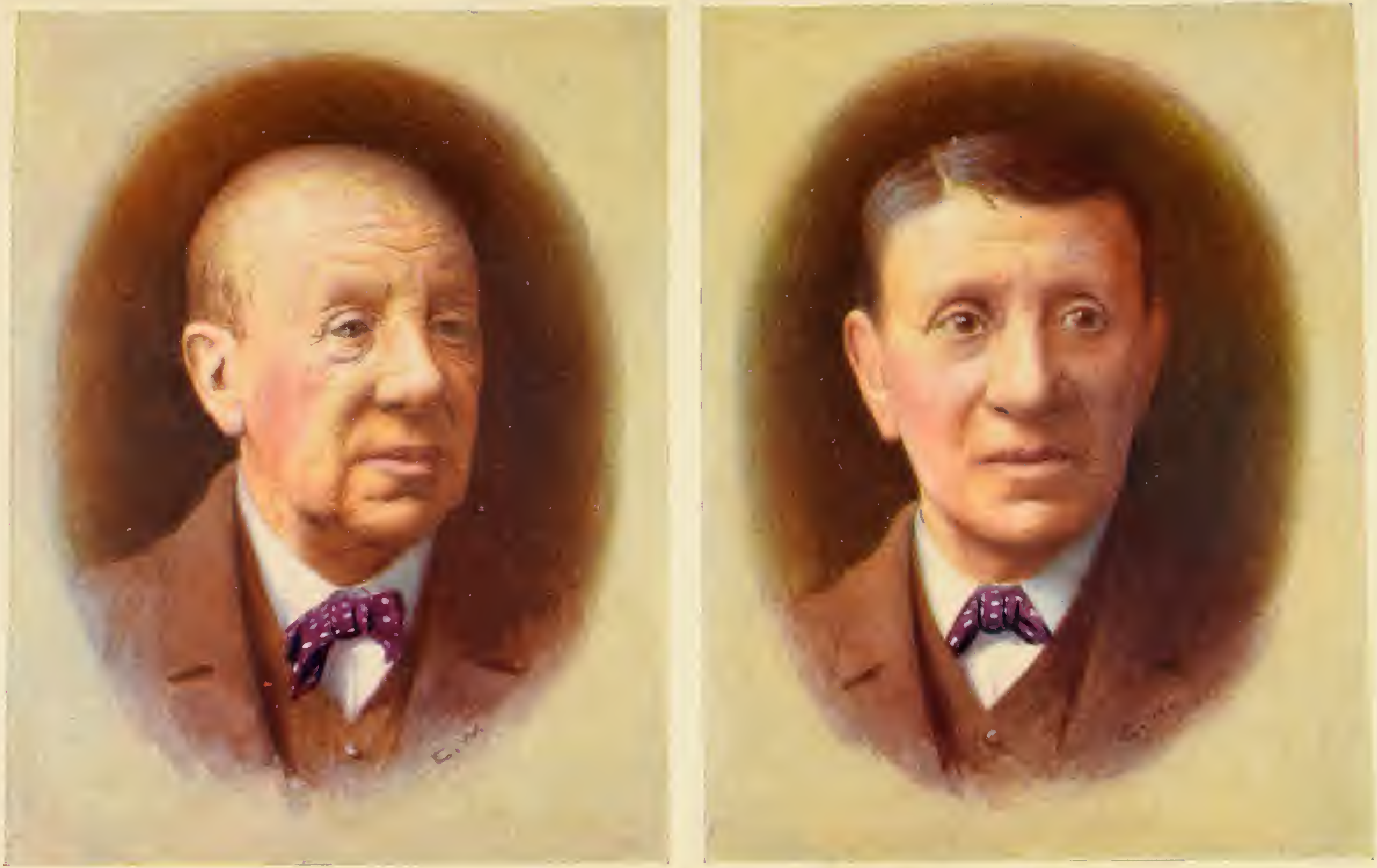
A CASE OF MYXŒDEMA

This plate illustrates a disease—**Myxœdema** (see p. 289)—whose characters are so marked that the medical expert may recognize it at a glance.

The plate is from photographs of the same patient, taken at an interval of about six months. The illustration, marked "before treatment", shows the characteristic features of the disease, referred to on p. 16; the other illustration markedly emphasizes the beneficial changes produced by treatment, which in this case consisted in the administration of the raw thyroid glands from the calf.

PLATE II

To illustrate a disease the nature of which is apparent at a glance to the experienced observer



Before Treatment

A few months after Treatment

organs derive the raw material which keeps them in repair, if the physician could somehow submit the blood to examination and determine whether it was of a healthy standard. He will then probably suggest that it would be wise, next, to determine whether the apparatus which drives the blood through the body was fit to perform, and was actually performing, its work properly. Thereafter it would be natural to enquire whether the various organs whose duty it is to provide new supplies of blood-forming material seemed in a healthy condition, and next to submit to examination the various organs whose business it is to purify the blood of the waste matters thrown into it on its way through the body. Finally, considering that all the organs are regulated and controlled by the nervous system, one would conclude that a careful investigator would not omit to apply some means of testing the integrity and activity of the nervous system.

That is to say, in any case of illness in which there are no pronounced indications, it is only by a careful and methodical investigation into the quality of the blood, the soundness of the heart and system of blood-vessels, the character of the various processes of digestion, the nature and amount of the food- and drink-stuffs supplied to them, the condition of the organs of breathing, the action of the kidneys and skin, and the integrity of the nervous system, that the physician obtains the material for the formation of an opinion. But even when he has obtained all the facts that such an investigation yields, the task of the physician is not completed. He has to put all these facts together in order to realize in his mind how this bodily machine he is investigating is working, where the defect is likely to lie, and how that defect influences the state of the whole body. He may find faults and errors of one kind or another, but that is not sufficient. He must be able to decide whether these faults are adequate to explain the condition of which the patient complains. The art of the physician undoubtedly consists in the thoroughness and accuracy with which all the facts connected with the patient's state are observed and collected, but it consists also, to an even still greater degree, in piecing all the facts together and realizing how this defect in one organ and that other defect in the other have worked together to put a strain upon a third too great for it to bear, so that gradually the whole bodily machine has got out of gear.

The facts connected with all the various organs, which it is the business of the physician or surgeon to observe before he makes up his mind as to the exact nature of the ailment from which his patient is suffering, may be likened to the pieces of a puzzle picture lying scattered about. When all these pieces have been properly fitted together, then the person sees that a picture has been built up; so the physician, having collected all his facts, proceeds to piece them together, and produces in his mind a disease-picture, by which he recognizes the ailment with which he is dealing. Just as in the puzzle picture a child will often contrive to fit in, apparently well enough, a piece that really does not belong to that picture, and an older child coming along points out that really that piece does not belong there, since, though its shape suits, it is a bit of another picture altogether, so a patient will often come complaining to a physician of some symptom which to him is the important matter, but which the physician, after careful examination, finds to be of really no importance whatever, other and far more significant things having totally escaped the patient's notice.

Modern Methods in the Detection of Disease.

These pages have been written in vain if the intelligent reader does not here feel tempted to remark: "Why, then, the art of medicine is a much more difficult and scientific thing than I had imagined, and I should think those who follow it would be constantly on the alert to bring to their aid new methods of investigation, and to bring to bear on their task more and more accurate and refined methods of observation." Exactly so! and it will not be out of place here if we try to illustrate how the science of medicine has been enabled, in quite recent years, to make enormous advances in the detection and explanation of disease by the application of newer and more scientific methods of observation.

The Microscopical Examination of Blood in Disease.

Let us go back to the blood. We have seen that it is from it, streaming through them, that all the organs and tissues of the body obtain material for their work and repair, and into which is washed all the waste of the organs. Even if we did not know it to be a fact, it could easily be argued, that many disease-conditions may be due to the blood-stream being of a kind unfitted to fulfil its task of supplying the organs with what they need. What a boon it would be if the physician had any easily-applied means of testing the blood and of determining whether or not it was up to a healthy standard, and contained a due proportion of proper ingredients, and was free of injurious constituents! But how difficult a task this is! How difficult it is to determine about ordinary water whether it is of proper quality or not. A man who is about to take a house in the country is concerned about the water-supply. He supplies a gallon or two to an analytical chemist and gets a report. But even the analytical chemist will admit that there may be in the water injurious constituents which elude his methods of detection. How often is an outbreak of typhoid traced to a water-supply, and yet the chemist may find it a matter of extreme difficulty to detect the impurity causing the epidemic! Yet the chemist may have as many gallons as he pleases to experiment with. How much blood can a physician afford to abstract from a patient for his investigation? He must work with drops. And what laboratory methods can be employed with drops? At the outset it is clear the physician is placed under limitations that almost seem to make successful observations impossible. Yet the genius of the scientific physician has succeeded in showing these limitations to be not impossible to overcome. Professor Ehrlich of Berlin has shown how, with just a tiny droplet of blood, information, as to the character of the fluid, of the utmost value may be obtained. On a glass microscope slide a small drop of blood, freshly drawn from the point of the patient's finger or tip of the ear by a clean needle, is spread in a thin film and allowed rapidly to dry. The slide is then heated for half an hour at a temperature of 110° Centigrade. The apparatus for heating the slides is of the simplest possible kind, and yet perfectly reliable. The slide with the dry film is now immersed

PLATE III

THE MICROSCOPICAL APPEARANCES OF BLOOD CELLS AND THEIR VARIETIES

The left-hand illustration is an exact reproduction of a blood-film, made as described on p. 18. It illustrates healthy blood cells; the film has been stained by immersion in a solution of eosin and logwood, and the figure represents a field under a $\frac{1}{12}$-inch oil immersion lens. The most numerous cells are the red ones, and they are remarkably uniform in shape, size, and degree of colouring. Two white cells are shown, one with a single large logwood-stained nucleus, the other with an irregularly-shaped multiple nucleus. These are the chief forms of white cell of healthy blood, the first being called a **lymphocyte**, the other a **poly-morpho-nuclear leucocyte**.

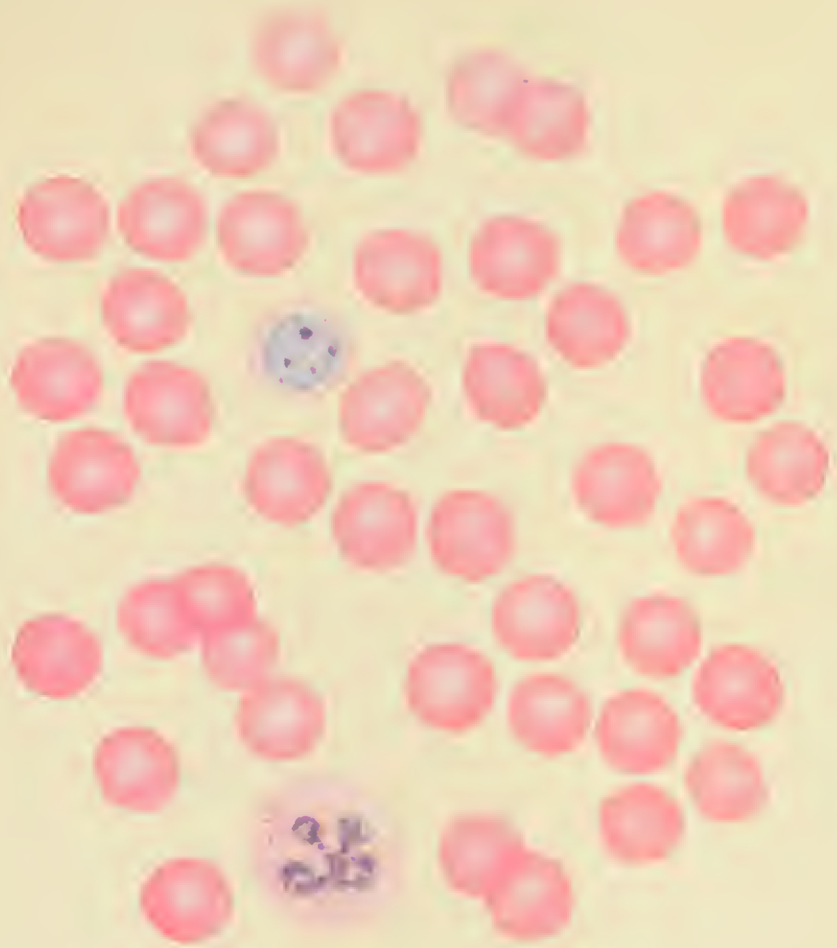
The right half of the plate is not a reproduction of an actual film, but is a diagram in which there have been drawn four groups, a, b, c, and d, of cells, showing the varieties, a and b of white cells, c and d of red cells; found, a and c in healthy, b and d in diseased, blood. They are represented magnified the same degree as the cells of the left-hand illustration, but the blue staining is given by methylene blue instead of logwood.

Of group a, 1 and 4 are cells similar to the white cells of the left-hand film, 2 and 3 are other varieties of 1; 5 is called the **Eosinophile** cell, and 6 the **mast-cell**.

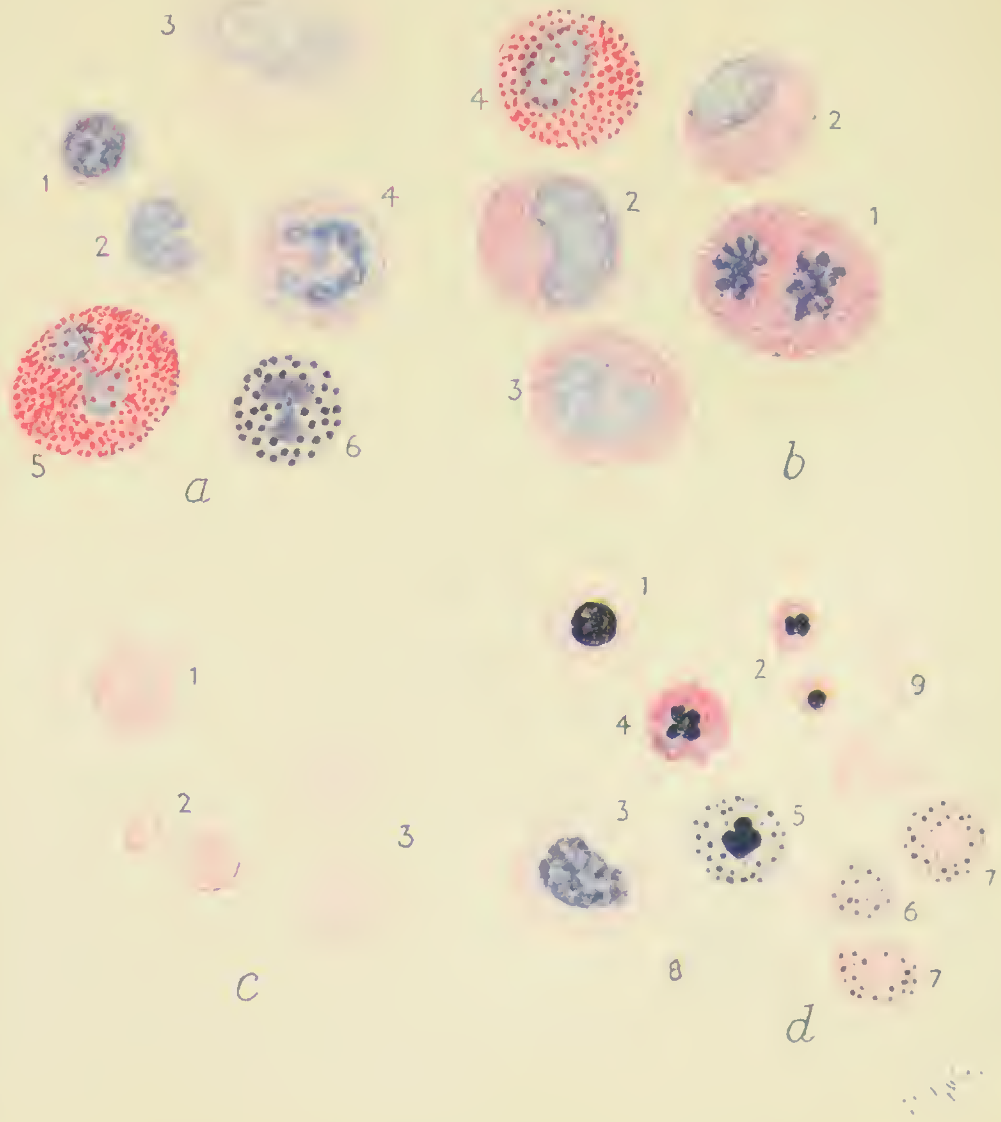
Of group b, cell 2 is the **mono-nuclear neutrophiles** only found in disease, 1 is a similar cell undergoing nuclear division, 3 and 4 are normal white cells.

Of group c, 2 and 3 are variations of the normal size 1, while group d shows in 1, 2, 3, and 4 nucleated red cells, never found in health, and in 5, 6, 7, and 8 red cells exhibiting irregularities of staining, which healthy cells never do, and in 9 irregularities of shape.

PLATE III



A Film of Healthy Blood, stained with eosin and logwood and magnified 1000 diameters.



Drawings of Blood Cells, stained with eosin and methylene blue and magnified 1000 diameters.
(a) White cells of healthy blood. | (b) Red cells of healthy blood.
(c) White cells of diseased blood. | (d) Red cells of diseased blood.

for from a half to two minutes or so in a mixture of aniline dyes. It is then washed in water, dried, and then a drop of Canada balsam placed on it, and covered with a thin slip of glass. It is then ready for examination by a high-power microscope. A picture is seen under the microscope such as is shown in Plate III. This is an exact drawing from a slide of the author's. In this case the mixture of dyes contained a substance called eosin, which gives a salmon tint, and also logwood. A large number of rounded bodies are seen, coloured by the eosin, the exact shade being dependent on the length of time the slide is left in the solution. Other two bodies are seen, one with a rounded logwood-stained mass in the centre, and another in which the central logwood-stained substance is irregular in shape. The more numerous bodies are the red cells of the blood, the other two are white cells. The logwood-stained masses are nuclei.

It is not so many years since blood was described as a nearly colourless fluid containing two kinds of solid bodies, one straw-yellow, of rounded outline, and another white and of an irregular globular shape. That is to say, there was one kind of red cell and one kind of white cell. But Ehrlich, by his methods of staining, has been able to show with absolute clearness that the red cells may vary in size and shape, and that even in healthy blood there are not less than five or six different varieties of white cells, and these differences are revealed by the way in which the different varieties behave in reference to different staining solutions. For observe that this film shown on Plate III. was immersed in a mixture of two colours, but the red cells have become stained by only one of the dyes, while the white cells have taken up two, different parts of the white cells having become dyed by the two, the central mass selecting the logwood and the surrounding part of the cell the eosin. Observe further that it is this selective power of different parts of the cell for different dyes that enables one to perceive that two apparently similar white cells are really different from one another, since the central mass of one shows up rounded, and that of the other irregular in shape, after they have been stained in the same solution. But what is represented on Plate III. shows only a tiny portion of the blood film, and if the slide, from which this is taken, be moved about under the microscope, it soon becomes evident that, while all the red cells are more or less identical, there are several kinds of white cells present.

The other side of Plate III. does not show a fragment of one film, but represents drawings of various kinds of red and white cells that may be found in films made from the blood of different patients. The collection of six cells marked A, for instance, shows the different kinds of white cells that may be found in healthy blood stained after the method indicated, by eosin and methylene blue. Of the six, for instance, No. 5 has a blue-stained mass, dumb-bell in shape, in the midst of substance which, by the way in which it has taken up the eosin stain, is obviously coarsely granular in structure, while No. 4 differs from it not only in being finely granular, but in taking up the colour less greedily, being therefore much less brilliant, while the blue-stained portion is irregularly twisted and knotted. Again, No. 3 differs from both of these, since its main substance hardly takes on the stain at all, and has only a very faintly mottled look, its blue-stained substance standing out very prominently in the large faint gelatinous-looking mass. No. 1, again, is a small, very compact cell, taking on none of the pink colour, its deeply-stained blue mass nearly filling the whole cell; while No. 6 differs from all of these in that, quite unlike all the others, there are, quite clearly, coarse granules of some substance scattered about the whole cell which take on the blue colour strongly. Now, an expert in cloth goods might test a piece of cloth in a similar way by immersing it in a dye solution. Let us suppose he immersed a piece of white cloth, said to be wholly woollen, in a navy-blue dye. After dyeing it, he would show to your eye that it was not what it professed to be, since it did not dye uniformly. He would point out to you numerous threads which had not become coloured like the rest, but were clearly shown as whitish strands in the general blue-stained texture, and he would tell you these were cotton threads which had been mixed with the wool and were revealed by their failure to take up the colour. So, by the use of an appropriate mixture of dyes, he could show you that in a piece of cloth, which was said to be made all of one material, there were portions of silk, wool, cotton, and linen, because they all behaved differently in the degree and shade with which they became coloured. In the same way the physician can stain a film of blood and then determine the different varieties of cells it contains by the varying ways in which they take up the stains. All this Ehrlich and his followers have done for blood, and, as has been said, a single tiny drop of blood taken from any patient can be submitted to such a test within an hour, or, indeed, by other similar means, within ten minutes.

Now the value of all this becomes evident when it is stated that observations have shown that **healthy blood always contains certain cells and certain cells only**, and that healthy blood always contains these cells **in a certain definite proportion**. For by measuring the drop of blood used, for which instruments have been devised, the proportion of red and white can be determined, and the number of the different kinds of white cells also estimated, and so it can be determined whether the sample taken is of a normal healthy standard or not. But this is not the whole story, for observations have shown, beyond the possibility of question, that in certain diseases the proportion of red cells to white varies, and the proportions of the different kinds of white cells alter.

And now comes a most important point: there are certain diseases in which **the proportion varies always in a certain way.** It is, indeed, an absolute truth to say that it is now possible to determine, in one or two cases, the exact nature of the disease from which a patient is suffering, by the examination, in the way stated, of a single drop of the patient's blood.

Take Plate IV. and compare it with that part of Plate III., the left-hand side, which shows healthy blood. The left-hand side of Plate IV. shows, accurately reproduced, a portion of a blood film under the microscope. At once it will be noticed that there are no cells with blue masses; no white cells are present, that is to say. Then note how faintly the red cells are stained, how they all appear as if, in the central parts, there was a deficiency of staining substance, and how, instead of being more or less uniformly rounded, they are oval, some of them pear-shaped, and how, in comparison with the healthy film of Plate III., they vary greatly in size, small ones being numerous. Anyone familiar with the appearance of

PLATE IV

MICROSCOPICAL APPEARANCES OF BLOOD IN ANÆMIA

These are as exact drawings as possible from preparations of the author's, made in the same way as the film of healthy blood shown on Plate III.

The right-hand illustration shows the irregularities in size and form the red blood-cells assume in simple anæmia, and the absence of white cells from this film is not accidental, their number being reduced in anæmia. It also shows how feebly the cells take up the stain.

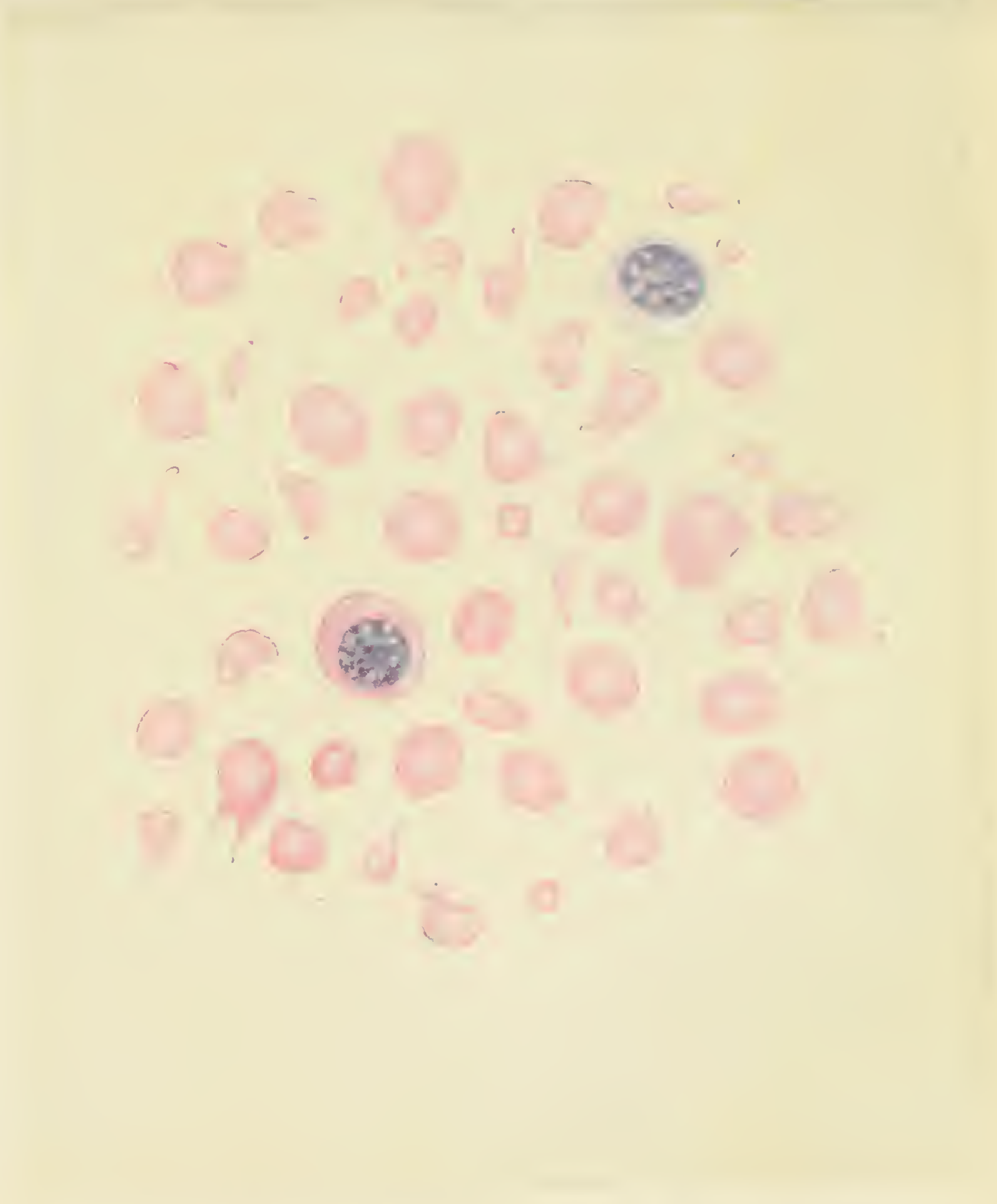
The right-hand film is from a case of pernicious anæmia (see p. 314). The irregularity of form, technically called poikilocytosis, is very marked. There is one very large nucleated red cell—a megaloblast; the other nucleated cell in the upper right-hand corner is a white cell—a lymphocyte.

These cells take up more stain than those of the left-hand film; and this is a feature of pernicious anæmia, distinguishing it from simple anæmia. Though the red cells are enormously reduced in number, each cell has if anything *more than* its share of colouring-matter.

In simple anæmia red cells are greatly reduced in numbers, but each cell has also less than its share of colouring-matter.

PLATE IV

Film of Blood in Anaemia, stained with eosin and methylene blue and magnified 1000 diameters



Film of Blood from Pernicious Anaemia, stained with eosin and logwood and magnified 1000 diameters

stained blood under the microscope would be able to state at once that, at any rate, the patient from whom this blood was taken suffered from anæmia.

Next look at the film on the right-hand side of Plate IV. and compare it with that of the left-hand side and with the healthy film of Plate III.; it differs from both. Its cells are markedly misshapen, they take up the dye irregularly, some of them being deeply stained in comparison with others. A little below the centre is a very large cell, deeply stained pink, a red cell, that is, but exceptionally big. Besides, this very large red cell has, what not a single red cell of the healthy film possesses, a deeply-stained blue mass. It is a nucleated red cell, a thing a few years ago not supposed to exist in human blood. This single nucleated red cell marks out the blood at once as diseased, for it is never found in healthy blood, and is always found in a particular kind of blood disease. Here, too, white cells are few, only one being seen—a large white cell which barely takes up any red stain, but has a deep-blue nucleus. It is seen up in the right-hand corner. This blood-film is from a case of pernicious anæmia, and the characters of the film declare the nature of the disease.

Contrast now these plates with Plate V. The staining here is a different mixture from the preceding, eosin being replaced by an orange dye, green being added also. Probably the first notable difference between these two films and those which have gone before is in the large number of white cells present, which were almost wanting in the preceding two. There are no less than twelve present, all of one kind, in the left-hand film, and ten of varying kinds in the right-hand film. In the left-hand film of Plate V., the white cell present is that most numerous in healthy blood, but it is present here in enormously excessive proportion. In the right-hand film there is a white cell present, found in healthy blood, but in such small numbers that one has to search for it. In this fragment of a film two samples are present, but the most numerous white cell of this film, that with the fine, somewhat violet, granules with the kidney-shaped blue mass, is never found in healthy blood, while there are also seen two nucleated red cells, the orange cells with the deep blue, almost black, irregular masses.

Note again the value of these films. Submit them alone to the inspection of a physician familiar with this method of investigating disease, and, in the case of the right-hand film, he will name immediately the disease from which the patient is suffering from whom the drop of blood was taken, while he will be able to say that the patient whose blood is shown on the left-hand side has suppuration somewhere.

By this time everyone has heard of appendicitis, and is aware how fatal a disease it is if the inflamed appendix suppurates. But there are some cases of typhoid fever which are distinguishable from appendicitis with the greatest difficulty. Now where an appendix is suppurating an operation may be the only means of saving the patient's life; but in some of these cases of typhoid fever resembling it, to operate might be to threaten, not to save, the patient. Any method which helps to distinguish between the two would be of inestimable value. In such circumstances a blood test may afford the only means, for in typhoid fever, as a rule, the blood-film shows few white cells; while, if the appendix were suppurating, the film would show the appearances represented in the left-hand film of

Plate V. Such appearances, therefore, if doubt existed, would go to decide for operation, while the absence of the white cells would decide against the operation.

These are only a few illustrations of the value of this new method in medicine. Others of the same kind will be found in the section on Infectious Diseases Section XXIV.).

The Roentgen Rays as Detectors of Disease.

Take another kind of illustration of the value of the application of modern scientific methods to the detection of bodily disease

It is only ten years since Professor Roentgen of Würzburg made his famous discovery of the light rays, to call them so, which bear his name, the Roentgen or X-rays. The apparatus by which these rays are produced is shown on Plate VI.

An electric current, obtained from a battery or from storage cells, or, as in the case illustrated in the plate, from the town supply, is passed through an induction coil. This coil is marked C on the plate. It consists really of two large bobbins, so to speak, of wire, an inner one, b^1, of thick wire, and an outer one, b^2 of much thinner wire. In each bobbin each turn of the wire is insulated from its neighbour, and the two bobbins are carefully insulated from one another. On the outer coil, in the one illustrated in the plate, the wire, if unwound, would stretch five miles. The inner coil (b^1) is connected with the brass binding-screws, shown at the right-hand front corner, with which are seen connected the twisted silk-covered electric cords. The ends of the fine wire of the outer coil are connected to the upright pillars in front, one of which has the figure 2 beside it. Copper wire running in rubber tubes, marked 1 and 2, are connected with these pillars, and one of these wires, marked 1, is connected with one end of a glass globe contained in a wooden box supported on a stand. The other wire, 2, is connected with the other end of the glass globe. This glass globe has been exhausted of air. It is called a vacuum-tube, and from each side of the globe passes a glass tube, which has sealed in it a thin platinum rod. One platinum rod ends near the middle of the globe in a platinum disc, the reflection from which is seen on the glass; the other rod ends at the circumference of the globe in a small somewhat cup-shaped expansion. A gap of a few inches separates the disc from the cup-shaped expansion. On the wall, contained in a case, the doors of which are open, is a slate slab, on which are fixed various switches and plugs. At the upper part of the slab the white face of an instrument is seen, which measures the current passed through the coil b^1, and high up on the wall at the side, outside the case, is another instrument of a similar appearance, which measures the pressure in volts of the current used. The other instruments on the slab are switches for sending the current in different directions and for varying its strength. On the left-hand side, in a small case marked B, is an instrument through which the current is passed before it goes to the coil b^1. This instrument consists of a wheel driven by a motor. The wheel is contained in a glass vessel, with a layer of mercury at the bottom, and filled with petrol. With each single revolution of the wheel the current is sent on to the coil three times and broken three times, and by moving the handle on the switchboard marked m, the wheel may be revolved at varying rates of speed.

Plate V

MICROSCOPICAL APPEARANCES OF BLOOD IN CASES OF SUPPURATION AND LEUKÆMIA

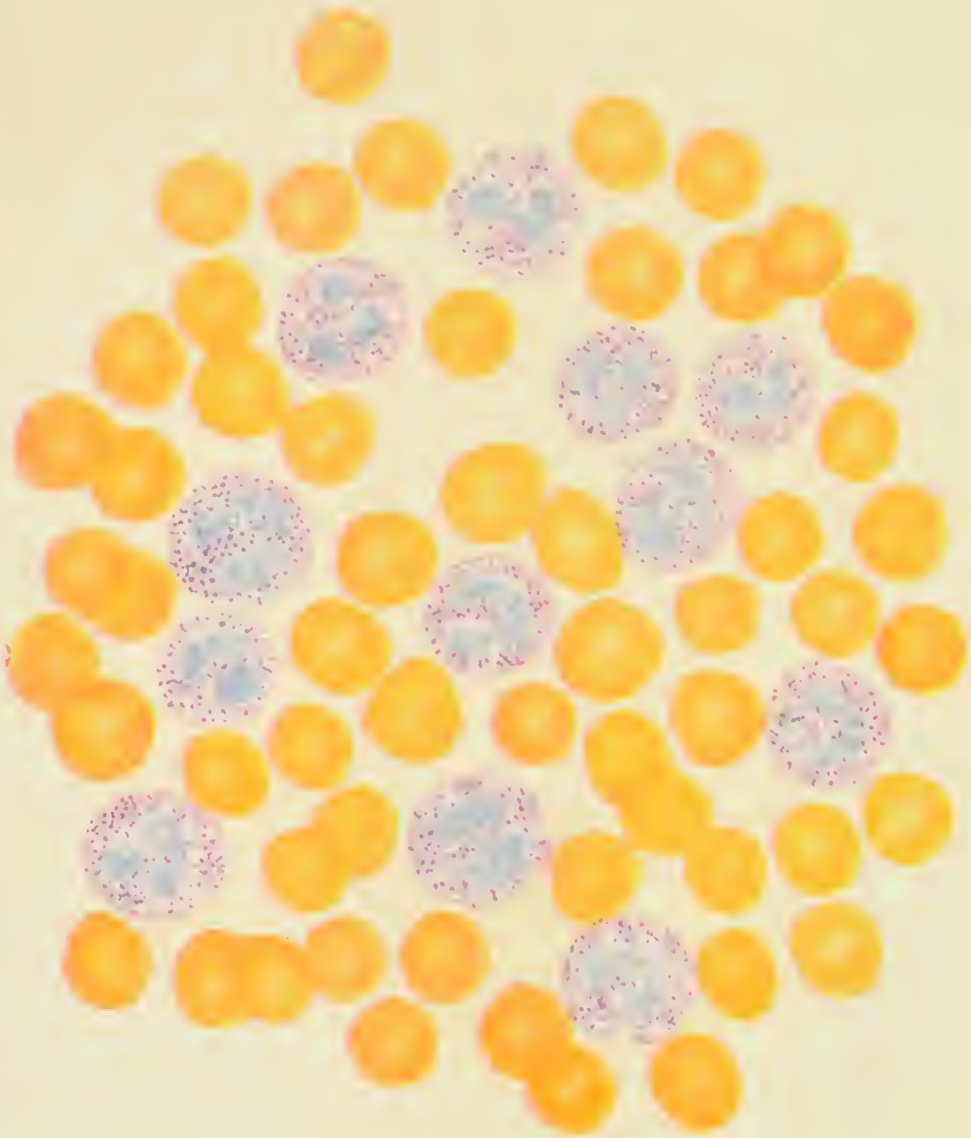
These two figures are also exact reproductions of actual films, prepared in the same way as the film of healthy blood of Plate III, but immersed in a different stain.

The stain used in these cases was Ehrlich's triple stain, of orange, methyl-green, and eosin.

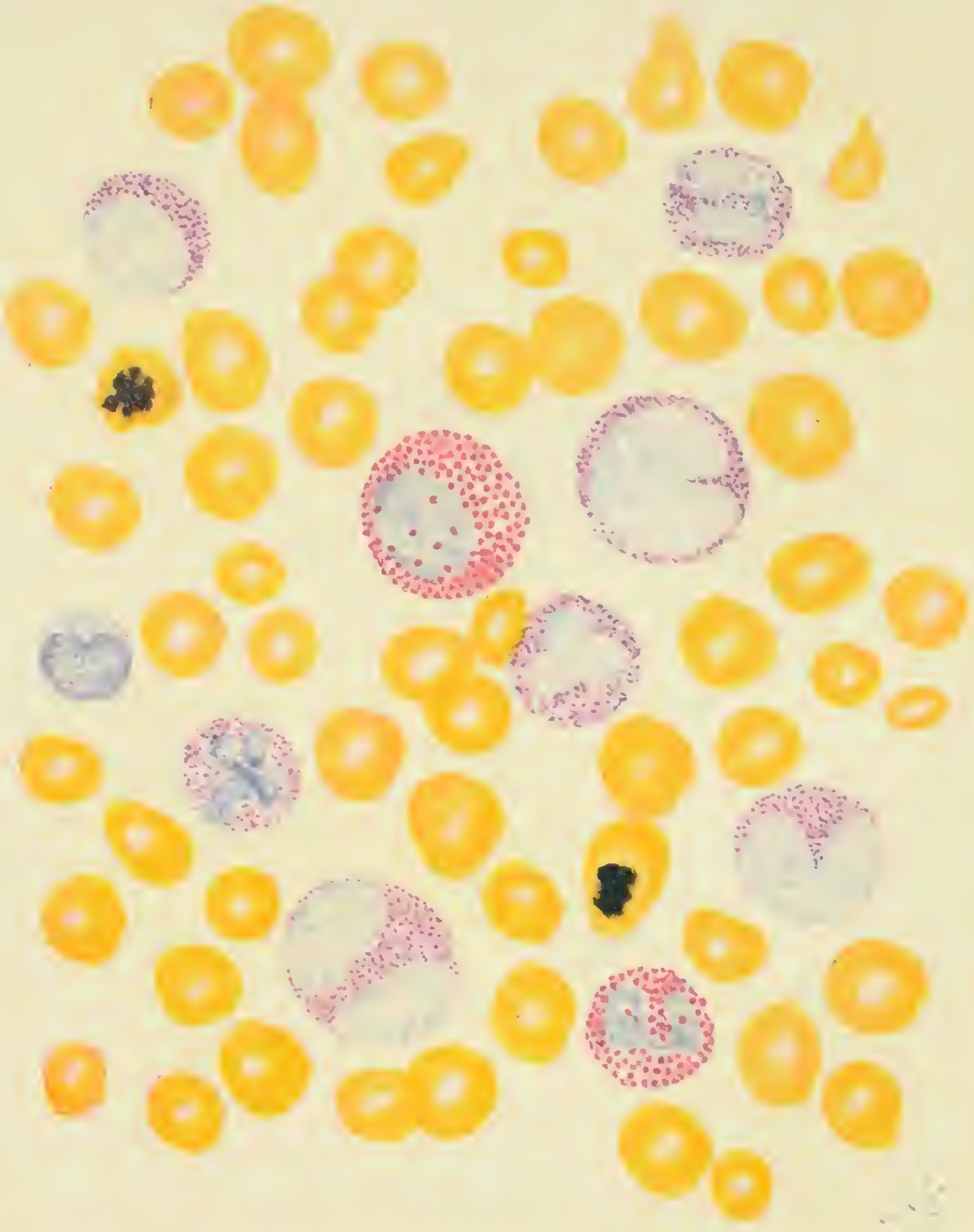
The left-hand illustration shows one feature, the great increase in the number of white cells, which are all of one kind, the poly-morpho-nuclear neutrophile. This change in the blood is significant of the formation of matter (pus) somewhere, and this film was from a case of extensive formation of matter under the skin of arms and legs.

The right-hand film is from a case of **leukæmia** (see p. 315). It shows irregularity of form and size of red cells (in this film, stained orange), it shows also two nucleated red cells, it shows marked increase in the number of white cells, but here, differing from the left-hand film, the white cell in greatest numbers is one unknown to healthy blood, the mono-nuclear neutrophile, or large marrow cell. There are five in this film, several of them showing a tendency of the single large nucleus to split into two. In this blood, too, the large cells with the numerous deeply-stained coarse granules—**Eosinophiles**—are more numerous than in healthy blood.

PLATE V



Film of Blood showing great increase of white cells (leucocytosis). Stained with Ehrlich's triple stain and magnified 1000 diameters



Film of Blood from case of Leukaemia stained with Ehrlich's triple stain and magnified 1000 diameters

Now if the current be sent through the inner coil, b^1, in a steady stream, nothing noteworthy takes place, but if the current flowing in b^1 be interrupted, with every interruption a current of electricity is produced in the outer coil, b^2—a current which endures only the briefest possible instant. This current is not a part of that flowing in b^1. It is simply induced by it, as the phrase is, and it is a current of a different quality, a more intense current than that of b^1. Every variation of the current in b^1 induces a momentary current in b^2. We have seen that by moving the handle *m*, the motor will be driven at varying speeds, and if the current be turned on to the coil b^1, it passes through the glass vessel in B, and is interrupted at a very high rate of speed by the revolutions of the wheel in the glass vessel. Further, the strength of the current, thus interrupted, may be varied according to the position of the switch marked C. Here then you have a means of sending a current through b^1, of varying its strength by means of the switch C, and of varying the number of times it is made and broken by moving the switch *m*. But every time this current is made and broken in b^1, a secondary current, as it is called, is produced in b^2, and the rate of interruption may be so great that the induced currents at b^2 may follow one another so quickly as to be practically continuous. Now these induced currents of b^2 are carried by the wires 1 and 2 to the vacuum tube T. These induced currents of b^2 are so intense that if the ends of the wires 1 and 2 were fixed in clamps near to one another, the electric current would fly across the gap, and if the rapidity of interruptions was great enough a stream of electricity would fly across the gap. But the ends of the wires 1 and 2 are connected with the platinum rods in the globe, and within the globe the platinum rods end at a little distance from one another. If the globe were filled with air, the electric sparks would pass across the gap from one to another in a stream, like a flash of forked lightning. But the globe is exhausted of air, and because of this circumstance the current does not pass in a flash, but, instead, illuminates the globe with a peculiar fluorescent glow. This glow is specially vivid on that part of the glass globe which faces the platinum disc. Under these circumstances, when the current is turned on, a more or less circular piece of the front of the glass globe glows with a vivid greenish-yellow light. It is here that the Roentgen rays are produced, and this peculiar glow is the evidence of their presence. From this area of the glass globe the rays pass out in every direction; but the glow is not the rays, for the rays themselves are invisible. They can, however, be made visible.

There are certain substances which become illuminated with a fluorescent glow if these invisible rays fall on them. One of these substances is platino-cyanide of barium. A piece of cardboard is painted with collodion varnish, and this platino-cyanide of barium is sprinkled in fine powder evenly all over it in a layer. When this is done it is fixed to a wooden frame. If this be held up in front of the tube, or if indeed it be anywhere near the tube, it glows with a peculiar yellow-green illumination. This is best seen in the dark.

This cardboard so prepared is called the fluorescent screen.

Think now of ordinary sunlight. It passes through a sheet of plain glass, and the glass is said to be transparent. But if the glass be coated, say with lamp-black, the sunlight will no longer pass through it, and it is now said to be opaque. A piece of wood, however thin, is opaque to sunlight; all kinds of metal are opaque; ordinary white paper is opaque to sunlight. But one remarkable character of these X-rays is that they will pass through many substances that ordinary light cannot pass through, that is to say, many substances opaque to sunlight are transparent to Roentgen rays. Thus the Roentgen rays will pass through wood and even brick; though they are kept back by most metals. Now if one paints a black disc, or pastes a piece of black paper, on a piece of plain glass, and then if one holds the glass up to the light, the light will pass through the glass everywhere except where the paint or paper is, which appears therefore as a round shadow on the illuminated glass. In the same way, if one holds up a fluorescent screen in front of the vacuum-tube, and if one then places between the tube and the screen something through which the Roentgen rays cannot pass, that thing will appear as a shadow on the glowing screen. A piece of wood placed between the tube and the screen will not show up on the screen, because the Roentgen rays pass through the wood and fall on the screen in spite of it. If a penny, however, or a gold coin, or a piece of lead, be placed between the tube and the screen, it will cast a shadow on the glowing screen, because the rays cannot pass through the metal, and the shadow on the screen will have a shape corresponding to the object that is barring the passage of the rays.

Now it is found that the various parts of the body behave differently to the Roentgen rays. Some of them are opaque, and some are transparent, and if a part of the body be placed between the tube and screen, shadows will appear on the screen corresponding to the degree of opacity of that part of the body. Bones, for instance, are more or less opaque to the rays, while flesh and fat are transparent, or nearly so. If, then, the hand be held up between the tube and the screen, the rays will pass through the soft parts of the hand and illuminate the screen, while they will be kept back by the bones of the hand, and the shadows of the bones will show on the screen, with their outlines more or less clearly defined according to various circumstances, such as the strength of the electric current passing through the tube, the distance of the hand from the tube and from the screen, and so on. And if on any of the fingers of the hand there be metal rings, their shadows will be clearly shown on the screen, and will appear as if encircling the finger bones. In the same way if a man stands in front of the tube, and the screen be placed in front of his body, the Roentgen rays will pass through the soft tissues of his body and illuminate the screen; but the bones of the spinal column and ribs will keep back the rays, and so on the illuminated screen will be seen the shadows of these bones more or less clearly defined. Moreover, some of the soft tissues of the body are less transparent than others to the rays, and therefore on the screen there will appear clearly defined shadows of the bones, and fainter shadows of some of the soft parts. The tissue of the heart, for instance, is not so pervious to the rays as ordinary flesh, and so if the man stand so that the tube is behind his back, and the screen is held in front close to his chest, there will appear on the screen the shadows of the bones of the chest wall, and also in its proper position the shadow of the heart.

Lead, we have said, is opaque to the rays, and so if a man has been shot in

PLATE VI

ARRANGEMENT OF APPARATUS FOR X-RAY WORK

For purposes of the photograph the various pieces of apparatus have been brought as close together as possible.

On the wall is **I**, a switch-board protected by a glass case, the doors of which are open. To this switch-board the wires are brought, carrying the current from the town-mains, or from accumulators, as the case may be.

Sm is the main-switch, which puts on or cuts off the current from the board.

Just below **Sm** is a plug with connecting wires to the large induction-coil, **C**.

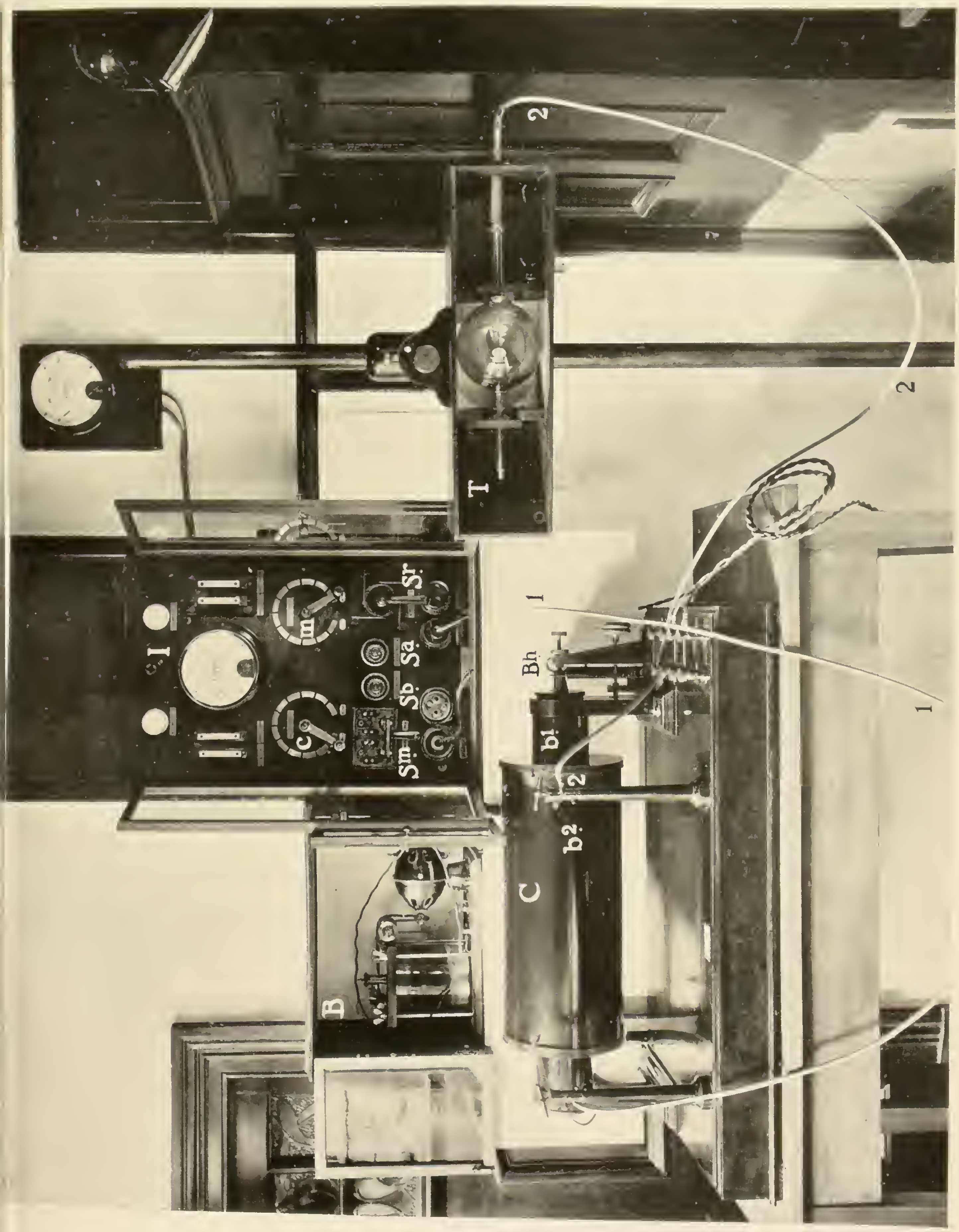
c is the arrangement for graduating the strength of the current passed to this coil **C**.

B is an interrupter interposed on the pathway of the current to the coil **C**, consisting of a wheel revolving horizontally in a glass vessel containing mercury and petrol. As the wheel revolves it makes and breaks with great rapidity the current to the coil **C**. The revolution of the wheel is effected by a motor, shown in the case alongside of **B**, which gets its current from the switch-board by the switch (**Sb**), the strength of which is regulated by the arrangement **m**. **Sa** is the switch for another interrupter on the other side of the main switch-board, which has been covered with paper to avoid confusion in the photograph.

Above **c** and **m** of the switch-board are fuses on the coil current and the motor currents, and an ampere-meter to measure the current passing through the coil, while on the wall above and at the side is a voltmeter to measure the pressure of the current in use.

The coil **C** consists of an inner bobbin, (b^1) of thick wire, and an outer bobbin (b^2) of thin wire, insulated from one another. The ends of the bobbin (b^1) are connected with wires from the switch-board through the plug below **Sm**. If the current passing through this bobbin is not on the way passed through the interrupter **B**, it may be passed through the arrangement **Bh** of the coil, where by the action of a spring it is made and broken. The ends of the fine wire of bobbin (b^2) are brought to the upright pillars, to which are connected the rubber-covered wires 1 and 2. The current induced in the bobbin b^2 by the making and breaking of the current in bobbin b^1 is therefore conveyed by the wires 1 and 2. These are connected to the ends of the vacuum tube in the box **T**. The interrupted current passed from b2 through the tube makes the tube glow, and on the glowing wall of the tube the x-rays are produced (see p. 23).

PLATE VI



the arm, and it is suspected that the bullet is still buried somewhere in the limb, it is only necessary to hold the arm up between the tube and the screen to discover where the bullet is, because, if still there, its dark shadow will be seen on the screen. Again, the gullet is not opaque to the Roentgen rays, and throws, therefore, no shadow on the screen; but if a person has swallowed a coin, which is suspected to be lying caught somewhere in the gullet, the person need only stand in front of the tube, and the screen be placed close up against him, when, if the coin is there, its shadow will appear, and its exact position may be fixed in relation to the bones, which also show up on the screen. Similarly a piece of needle may be thus located in a finger, and so on. Moreover, if the arrangements be so made that sharply-defined shadows are produced on the screen, the exact shape of the bones can be readily determined, and a bend of a bone or a thickening on it, or a crack or break in it, may be detected. How numerous, therefore, and valuable are the uses to which the Roentgen rays may be put in medicine and surgery is apparent without further words.

The Roentgen rays, moreover, act on photographic plates as light does, and if, instead of the screen, a photographic plate be held, the shadows will be fixed on the plate, which can then be developed in the ordinary way. For this no camera is needed. The plate need only be enclosed in a light-tight envelope, and held in place by the screen; for though the light cannot pass through the envelope the X-rays can. Plate VII. gives three simple illustrations of such photographs from the author's own collection. The upper one shows a halfpenny in a child's gullet, which had lain there for three months, giving rise to no discomfort, before its position was located by means of an X-ray photograph. It was known that the child had accidentally swallowed the coin, and though careful search had been made, its location had not been discovered. It was easily extracted from the child, put under chloroform for the purpose.

The other two illustrations of the same plate show a piece of needle in a woman's thumb, and a fracture of the end bone of the forefinger.

There is little difficulty in photographing, by means of the Roentgen rays, the bones of the body, and in determining quite certainly the nature of an injury or accident which has involved bones or joints. It is not necessary even to remove the patient's clothes for this purpose, and whether a bone has been broken or dislocated can be quickly determined in this way. In the case of a fracture, too, which has been set and put up in splints or in plaster, the Roentgen rays and fluorescent screen will show whether, when the bandaging has been completed, the bones are in proper position, and from time to time, if necessary, without the removal of a single turn of bandage or single pin, it can be seen whether any change of position has occurred, for wooden splint and plaster bandage are alike transparent to the rays. In some heart and lung and blood-vessel affections, too, the use of the Roentgen rays gives most valuable aid in the detection of disease. The heart throws a marked shadow on the fluorescent screen, and so its exact position in the chest, and whether it is of normal shape and of the usual size, can be easily determined.

Plate VIII. is an illustration of this. The upper part of the plate shows the shadow of a heart of normal size, and the lower shows a heart suffering from dilatation. It will be noticed in these plates that the lungs throw no shadow. The area of the chest occupied by them is clearly illuminated, but if the lungs be the seat of tubercular deposit the affected portions are less transparent than the still healthy parts, and this is indicated by a lessened clearness of the affected parts. (See Plate XVIII.) The fluid which collects in the chest in pleurisy with effusion, or where matter has formed, produces also a diminution of the clearly lighted area, and so the presence of fluid can be recognized by the experienced eye. In the same way a tumour in the lungs reveals itself by its shadow.

In many other departments of medicine and surgery physicians and surgeons have, in recent years, brought into use scientific methods for the detection of disease, the benefit of which is reaped by sufferers all over the globe, the poor as well as the rich, since every well-equipped hospital can show these methods in daily use.

We have been endeavouring to illustrate what is really meant by a healthy state of body, and wherein a diseased condition differs from it, and we have been trying to illustrate also how intricate and full of difficulty is the task of determining where, in the body, disease may exist, and of accurately pronouncing on its nature.

We might now go on to explain how a physician or surgeon proceeds, let us say, in a case where a patient is suffering, or believes himself to be suffering, and where there are no very pronounced indications of the nature of his ailment. He has, as it were, to search the patient's body for evidences of his ailment. How does he conduct his search?

Before explaining this, it will be better to note some of the technical terms that are continually cropping up, and some facts as to the kinds and causes of disease that will be most conveniently stated here.

The Kinds of Disease.

From what has been said it will be clear that an organ of the body may show a departure from health (1) either in its "make-up", its structure, or (2) in the way in which it works. Suppose that instead of perfect there is imperfect structure, an organ or series of organs whose structure has by some means become changed, or has been from birth defective, there you have obviously disease. This disease need not always be apparent. For instance, take the case of an engine, the inside of whose boiler has become in some parts eaten into by rust. The parts will be thinner than should be, and will be therefore weaker than other parts not affected by rust. They will, therefore, be unable to bear the same strain as the whole plates of the boiler. Yet the engine may be working quite well, and no one be aware of the flaw. But suddenly let the steam gain a pressure greater than the thinned plate can stand, without warning it bursts, and the defect is suddenly and terribly revealed. Similarly, a man may go about in apparently perfect health, yet a flaw may exist in the structure of some of his organs which is unknown until the occurrence of a strain greater than the affected organs can resist. Take a not uncommon case: the blood-

PLATE VII

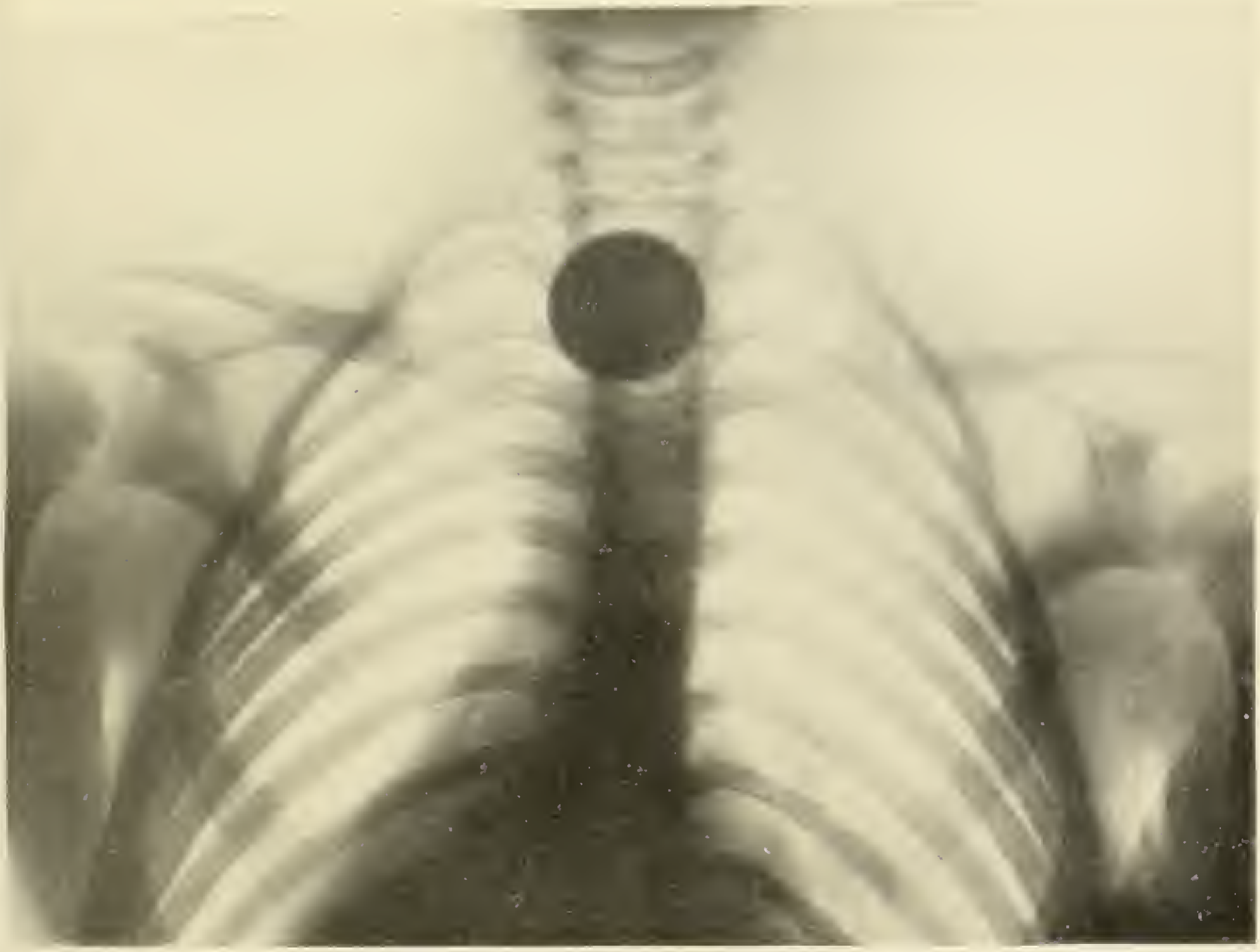
RŒNTGEN-RAY PHOTOGRAPHS

1. The first photograph shows a halfpenny which had lodged in the gullet of a child, aged nine years, where it lay for several months, giving rise to no inconvenience. Refer to p. 25.

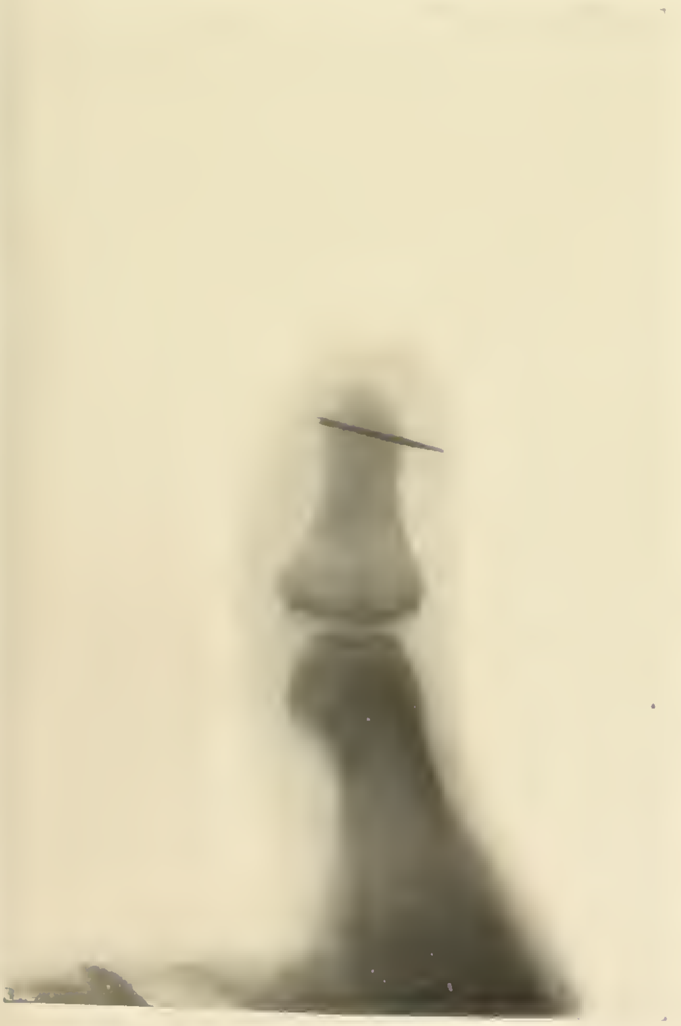
2. This figure shows part of a broken needle in a woman's thumb, and the needle is so sharply defined that its splintered end is quite distinct.

3. This figure shows the forefinger with the bone of the tip broken. It was the case of a gentleman riding in a gig, over a very rough road. To steady himself he placed his hand on the splash-board, the fingers folded over the edge of the splash-board to secure a firm grip. With the bumping of the gig the splash-board came down so near to the wheel that the finger was squeezed between the wheel and the under surface of the board. The photograph revealed the fact that the bone was broken.

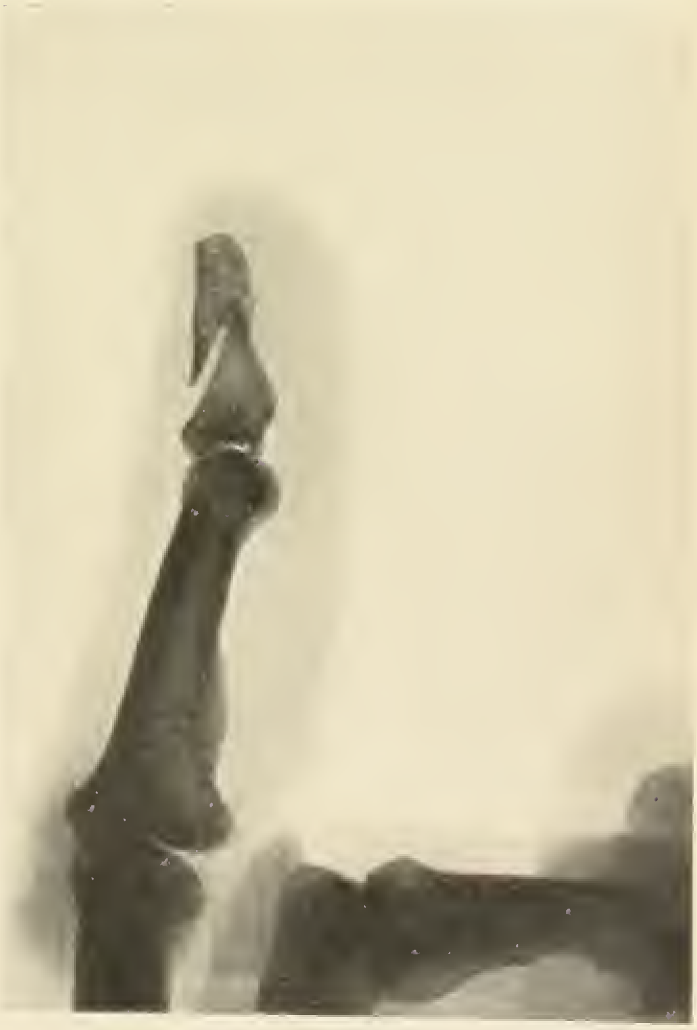
ROENTGEN OR X-RAY PHOTOGRAPHS



1. Roentgen-ray Photograph of Halfpenny in Child's Gullet



2. Roentgen-ray Photograph of Needle in Thumb



3. Roentgen-ray Photograph of Broken Finger-Tip

vessels of a person have, through age or other causes, become weak and inelastic. The man one day becomes excited, his blood rushes with unusual force through the body, driven by the excited heart, some small vessel in the brain, unable to withstand the increased pressure, gives way, and the man drops down unconscious, and soon dies. Thus, then, there is a class of disease due to defective structure of the organ or organs, and these are called **organic diseases.** This change or defect in the structure in most cases occurs in the course of the person's ordinary life, but sometimes the person is born with the defect. Thus a child may be born with the heart imperfect, so that one side communicates with the other (see DISEASES OF CHILDREN), or with eyes the lenses of which, instead of being clear and transparent, are opaque, so that the child is blind. (See DISEASES OF CHILDREN—*Cataract.*) Such structural diseases, born with the child, are called **congenital.** But, again, it is possible to have an engine, every part of which is properly made and properly fitted, and yet the engine does not work well or smoothly. The engineer finds nothing amiss, but he loosens a screw here, tightens another there, or oils some parts, and away the engine goes in perfect order. Similarly a man's body may, to all intents and purposes, be perfect as regards structure, that is, he has no organic disease, and yet he is not in good health. His heart may be quite perfect as regards structure, and yet it alarms him. He is troubled with palpitation or some other irregularity of its beating. In other words, an organ may be without defect in its make, but it may not work very well, it may not perform its duty properly. Now the duty an organ has to discharge, the work it has to perform, is called its **function.** Therefore a distinction is drawn between the class of diseases due to defects of structure, **organic or structural diseases,** and the class of diseases due to organs perfect in structure, but not performing their functions properly; and this latter kind is called **functional diseases.**

Besides this division into organic and functional, diseases are spoken of as being **general** or **constitutional** and **local.** A **local** disease is one which is confined to a particular part, and does not affect the rest of the body. Inflammation of the knee-joint, for instance, to which house-maids are liable, is a local disease. A **general disease,** on the other hand, affects all the body, such as scarlet fever, measles, diphtheria, &c. **Constitutional,** perhaps, means rather more than general. It means very often not only that the disease affects the nourishment of the whole body, but also that it is due to, or attended by, some peculiar condition of the body. For example, consumption, scrofula, cancer, are types of constitutional disease. These diseases do not merely make themselves felt by the whole body, but they impress on it a peculiar character.

There is a large class of diseases called **zymotic,** from a Greek word *zymosis,* meaning fermentation. These diseases are so called because it is believed they are due to certain poisons which get into the blood in minute particles or germs, and there increase and multiply, the disease lasting until the poison has become worked out, or has been destroyed. Small-pox, measles, scarlet fever, diphtheria, influenza, &c., are instances. These zymotic diseases may be **endemic or epidemic. Endemic** means that they are peculiar to certain localities or situations, such as goitre or Derbyshire neck, common in certain

Midland counties of England and in parts of Switzerland. Endemic diseases are generally due to some special causes connected with the district which they affect—its atmosphere, water-supply, drainage—and they tend to remain. An **epidemic disease** is one which suddenly comes among people and spreads through them rapidly far and wide, lasting for a time, and then dying away. Influenza, and scarlet fever, are instances. **Sporadic** is applied to such diseases when they are not endemic or epidemic, but occur, one here and another there, in scattered places with no apparent connection one with the other. See FEVERS.

Then there are diseases **hereditary**, which have descended from the parents, and diseases **acquired**, which the person was quite free from when born, but was attacked by at some later time. It must be observed, however, that the same disease may have been hereditary in one man and acquired by another.

Disease may be **acute, subacute, or chronic.** When it is **acute** it has a sudden onset, is severe, runs a certain course, and ends, generally, within a certain time. When it is **chronic** it has no such definite onset, course, or duration, and is not so severe. Its course is slow, it lasts longer, and may, indeed, never be finally got rid of by the sufferer. The **subacute** occupy a position between these two both in severity and length of time. These forms may, of course, pass into one another, the acute becoming chronic, or the chronic suddenly taking on the characters of an acute attack. In connection with chronic diseases there is employed a word **cachexia.** It means a bad habit of body, a bad condition which has become impressed on the body. It is, therefore, the result of disease, a permanent state which disease has produced. Thus the *scrofulous cachexia* is spoken of, the condition of body due to scrofula, shown by slender form, narrow or deformed chest, pallor, diseased glands, large prominent joints, &c. There is also the *cancerous cachexia*, attended by pale sallow complexion, a desponding expression of countenance, extreme thinness, &c. A person is said to be **cachectic** when he or she bears about such evidences of a chronic disease.

The Causes of Disease (ÆTIOLOGY OF DISEASE).

The causes of disease are usually divided into two great classes, **predisposing and exciting causes,** which we shall consider in detail.

A. Predisposing Causes of Disease.

Predisposing causes are those which so affect the bodily condition of a person as to render him liable to disease—such causes as so reduce the resisting power of the individual that, when attacked by the disease, he is unable to drive it off, and it takes possession of him. Now there may be causes rendering a person disposed or subject to disease in general, or there may be peculiarities about a person which render him liable to one disease in particular. Thus a man who is overworked or underfed is a ready victim for any disease which may come his way; he is like soil fit to grow any seed that may fall upon it; the man who comes of a consumptive family is specially open to affections of the lungs; and so on. The chief predisposing causes are the following, viz.:

PLATE VIII

RŒNTGEN-RAY PHOTOGRAPH OF THE HEART

TAKEN FROM THE BACK

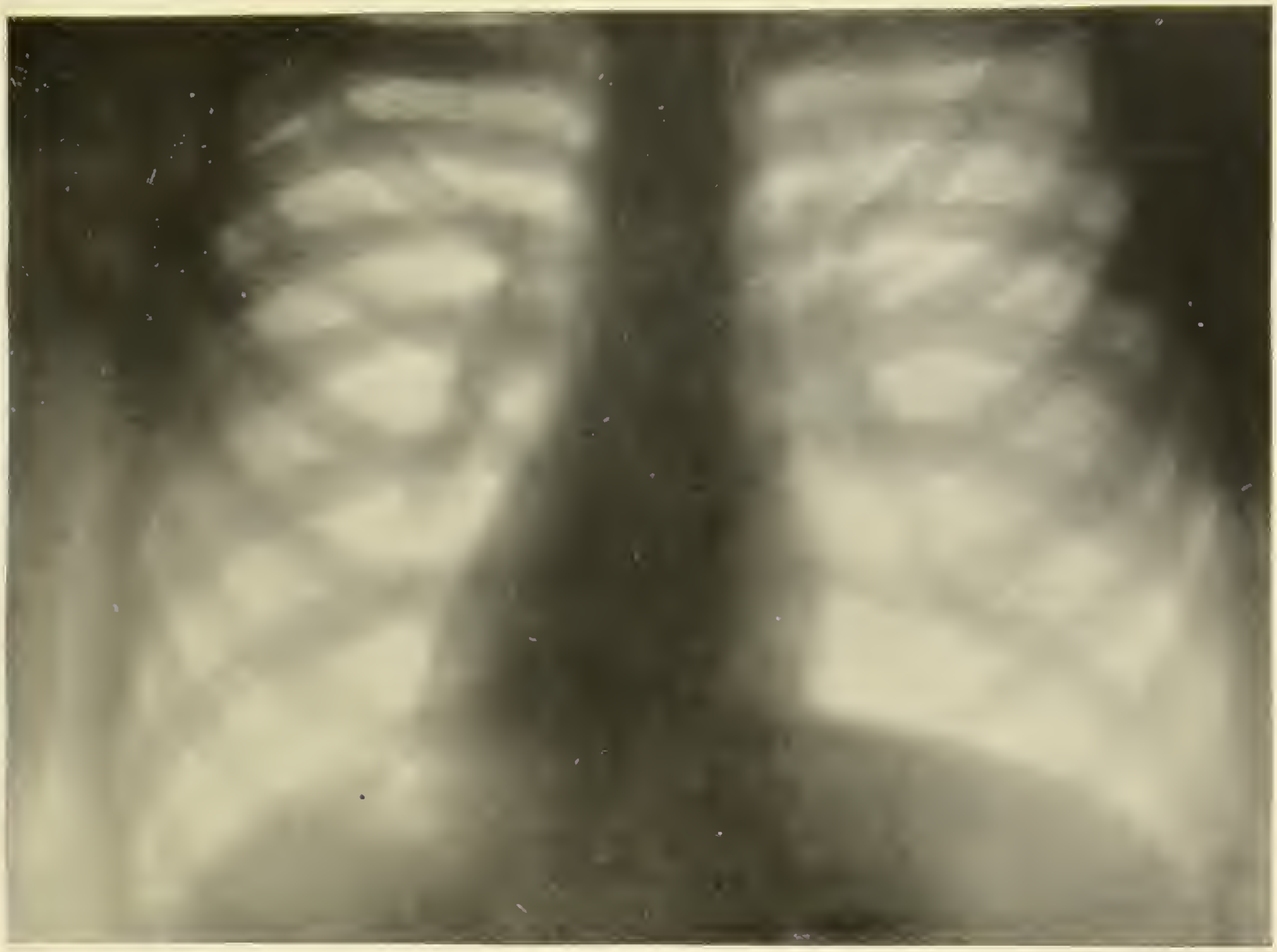
The upper photograph is of the chest of a youth of eighteen years. The x-ray tube is in front of the person, and the figure shows what is seen on the fluorescent screen (see p. 23) placed against the person's back. One sees the shadows of the ribs, the shadows of the back part of the ribs forming a criss-cross with the shadows of the front part.

The deep arched shadow of the lower part of the photograph is the arch of the diaphragm (see p. 345).

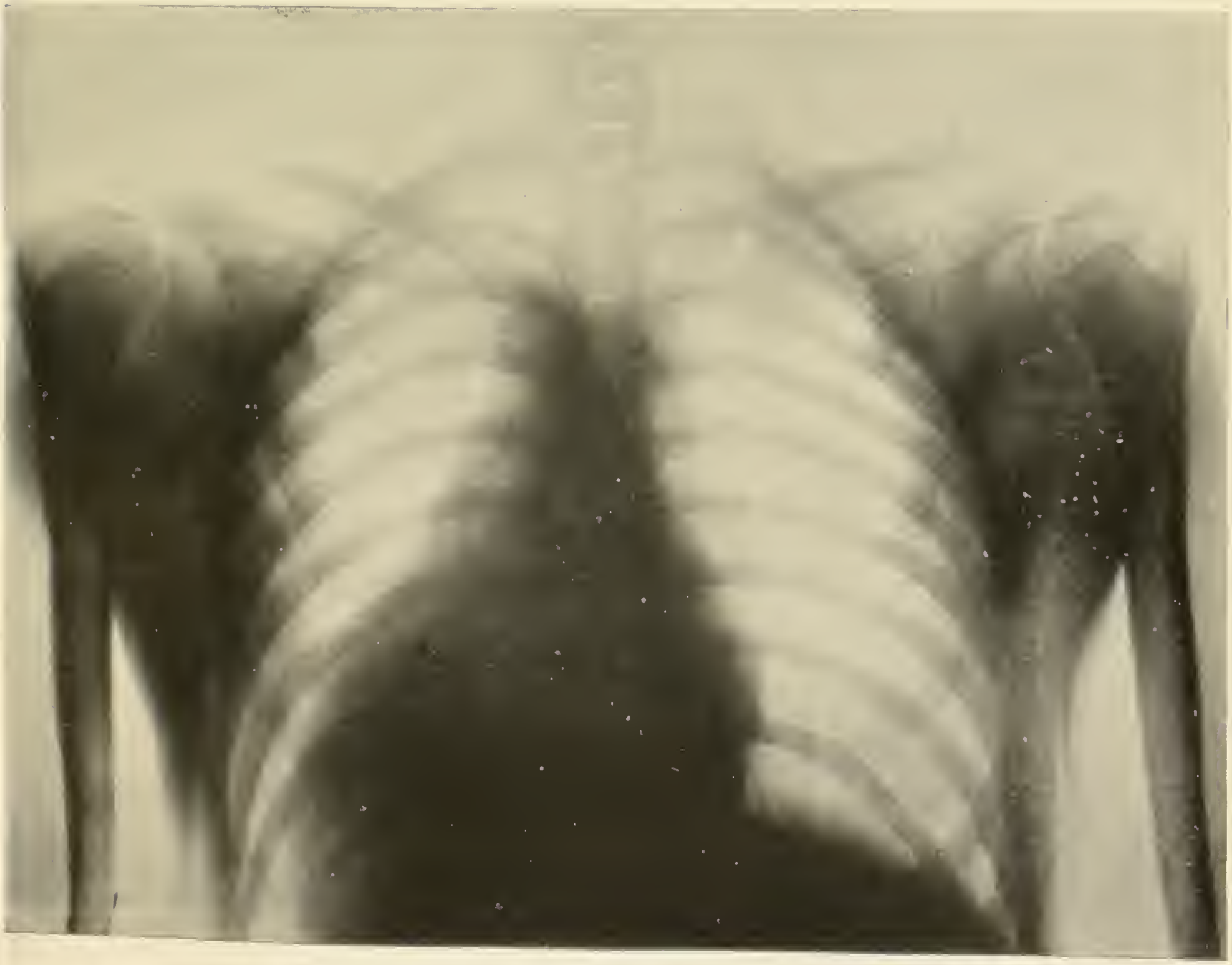
The vertical shadow in the centre is that of the heart and main blood-vessels. It will be noticed that the heart shadow forms a gently curved line to the right of the middle line, and a somewhat club-shaped outline to the left, the part of the shadow to the left being much larger than that to the right. That is to say, the heart lies to the left more than to the right (see p. 297). This heart is of normal outline.

Now compare this with the lower photograph, taken also from behind, in which the bulge of the heart to the right is more marked, but in which the extent of the shadow to the left shows the heart covers a greater area to the left than it ought to. This is the photograph of a dilated heart.

ROENTGEN PHOTOGRAPHS OF THE CHEST



Normal size, shape, and position of Heart, viewed from behind, so that left of photograph is left of Heart



Heart dilated to the left and generally enlarged, viewed from behind

1. **Age.**—Youth and old age are particularly susceptible of disease for easily understood reasons. The child is in a state of active growth and development, when the various organs are not fully grown nor their duties fully undertaken, and when the whole system is in a condition of great activity, and therefore easily disturbed. Thus the digestive organs may be easily disordered. The relation between the different parts of the nervous system of the child is not fully established, the spinal cord is highly sensitive, and so convulsions and other nervous disorders are frequent. Teething brings a multitude of attendant troubles. St. Vitus' dance, acute rheumatism, asthma, scrofulous disease, worms, are common among children, while they have great difficulty in avoiding infectious disease like scarlet fever, &c. A later period of youth, again, when the sexual powers are being formed, is a time of increased activity, and therefore of increased liability. On the other hand, old age is a period of decline, when all the powers are on the wane, when the ability to fight against attacks of disease is greatly lessened. This, therefore, is the chosen time for diseases of decay and degeneration, when the heart tends to become weak and fatty, the blood-vessels hard and brittle instead of elastic, and the brain soft, the time of paralysis and frailty of all kinds. As the reverse of this the period of maturity, when development has been completed, is the time of greatest power of resisting disease, just because all the bodily forces are in full operation.

2. **Sex.**—Women of course are liable to certain diseases from which men are, of necessity, free. Others very common to women attack men only very rarely, such as hysteria and forms of bloodlessness (anæmia and chlorosis).

3. **Surroundings.**—This includes the influence of air, heat, cold, moisture, of climate, &c. Some diseases are specially prevalent in the cold months, others in the warm months of the year. For instance, the effect of cold in producing bronchitis, of wet in producing rheumatism, of heat in producing sunstroke, is an illustration of this. Then the association between marshy undrained districts and ague is well known. Diarrhœa and dysentery, and affections of the liver, are common in tropical countries. Again, everyone knows that patients with a consumptive tendency seem specially benefited by residence on high levels and among dry, clear air. But even apart from differences of district or climate, the effect on health of surroundings more directly under the control of individuals themselves ought to be specially noted. The difference between the health and robustness of those who live in the town and those who live in the country is practically a difference of atmosphere. Similarly those who live in large, well-ventilated, roomy houses are in a much better position for fighting ill-health than those who spend their days in ill-ventilated or overcrowded apartments. Just for the same reason the part of a town where the streets are wide, and where there are parks or other open ground, has a better chance of escaping a visitation of disease than a part crowded with high closely-built houses separated by narrow lanes, and with no breathing spaces.

4. **Occupation and Habits.**—The two great kinds of occupation are the *sedentary* and the *active*. It is easily seen how the man whose business gives him physical exercise has an advantage, from the health point of view, over the man whose work keeps him closely confined to a study or desk. The man of sedentary

occupation, and those who work with their brains rather than with their hands, are frequent sufferers from indigestion, constipation, and the like. As regards special occupations, many of them have special diseases, such as *writer's cramp*, *wrist-drop of workers in lead*, particular kinds of *lung disease* and *disorders of the eye* in *miners*, and so on. As to habits, over-feeding has its tendency to disease as over-drinking has; luxury weakens rather than strengthens. Irregular habits of all sorts tend as much to encourage and invite disease as regularity is one of the strongest defences against it.

5. **Hereditary Influences.**—This signifies the influence exerted on a man by his parents and grandparents, for the influence may extend backwards through several generations. It affects his bodily structure and mental powers; and his personal peculiarities are often due to its effects. So that the influence of heredity on the liability of a man to disease, or to a particular disease, is very great and important. A remarkable instance, illustrating the transmission of a peculiarity of structure, may be given. A Maltese named Gratio Kellcia had six fingers upon each hand and six toes upon each foot. He married a lady having the usual number of fingers and toes; and they had four children. "The first child, a son, Salvator, had six fingers and six toes like his father; the second, George, had five fingers and toes, but one was deformed; the third, André, had five fingers and toes, perfect; and the fourth, a girl, Marie, had five fingers and five toes, but her thumbs were deformed. These all grew up and married five-fingered and five-toed individuals." . . . "Salvator had four children; they were two boys, a girl, and another boy; the first two boys and the girl were six-fingered and six-toed like their grandfather; the fourth boy had only five fingers and five toes. George had only four children; there were two girls with six fingers and six toes; there was one girl with six fingers and five toes on the right side, and five fingers and five toes on the left side, so that she was half and half. The last, a boy, had five fingers and five toes." The third, André, who was perfectly well formed, had many children, whose hands and feet were regular. "Marie, the last, who, of course, married a man who had only five fingers, had four children; the first, a boy, was born with six toes, but the other three were normal." Now it is to be noticed that if peculiar external form can be inherited, so also can internal form and structure. We know that the structure and development of an organ have great influence in determining health or disease, so that a man may inherit some peculiar form, say of heart, or brain, or liver, or some peculiarity in arrangement or relative size of blood-vessels, that may render him liable to particular kinds of disease.

It is well known how children resemble their parents in appearance, mental qualities, and peculiarities of disposition and character. It is supposed that the influence of the father is specially seen in the general form of head and limbs, while the influence of the mother is more internal, and affecting the way in which the vital functions are performed. It is also important to notice that peculiarities of the father will more surely affect the sons, and those of the mother will rather influence the daughters; and the father will less frequently transmit peculiarities to the daughter, and the mother to the sons. This is a rule, however, to which too much consequence must not be attached.

It is not only possible for a man to inherit from his parents a peculiarity which he transmits to his children, but he may himself acquire, by habit or otherwise, an entirely new peculiarity which he may hand down to his posterity, for habit has great power in producing peculiarities of constitution. Thus in two ways a man may affect his children: (1) by handing down to them something *he has inherited*, and (2) by handing down something *he has himself acquired.*

A very important question here arises, viz., "Is it possible for a man to influence in any way some such inheritance?" Suppose a man has inherited from his parent a peculiarity of temper or disposition which is inconvenient or bad, can he do nothing to prevent this being passed down to his children in full force? Laying aside peculiarities of form, it can be proved that an inherited habit or peculiarity can be strengthened and confirmed, and the probability of its being transmitted thereby greatly increased, by regular use, while it may be weakened by disuse, and the chance of it appearing in the children thereby diminished. So that a particular tendency may become quite confirmed in a family and characteristic of it by cultivation, while the same tendency may be caused to disappear by neglect.

The practical bearing of all this is more important in relation to health and disease. Many diseases are capable of transmission, principally rheumatism, scrofula, gout, syphilis, and insanity. As in the case mentioned above, malformations may be inherited. Besides these, certain nervous affections seem to run in families, such as asthma, neuralgia, and other diseases, for example, cancer, forms of skin disease, and fatty changes. Heart-disease, rheumatism, and St. Vitus' dance are interchangeable, that is, rheumatism in the parent may transmit heart-disease or St. Vitus' dance to the child. Similarly epilepsy or falling sickness, St. Vitus' dance, hysteria, and habitual drunkenness seem interchangeable; for instance, habitual drunkenness in the father may produce one of the other affections in the child.

To apply to disease what has been already noted:

(1.) A parent may transmit to his child either an *actual disease* or a *tendency* to it which he himself inherited from his parent.

(2.) A parent who has inherited a tendency to, say, insanity or drunkenness may, by unceasing care and precautions on his part, diminish the tendency in himself and lessen the risk to his children. The reverse is equally true, that a parent who, by his habits and mode of life, rather encourages the tendency and develops it, may transmit the tendency in greater force or a worse form to his children. It is of so far-reaching importance that as many people as possible should, for their own and the sake of society, be made aware of these things, that the following striking example of the course of hereditary disease unchecked in four generations is given:—

First generation: Immorality, depravity, alcoholic excess, and moral degradation in the great-grandfather, who was killed in a tavern brawl.

Second generation: Hereditary drunkenness, attacks of mania, ending in general paralysis in the grandfather.

Third generation: Sobriety, but tendencies to delusions, delusions of persecutions, &c., and tendencies to homicide in the father.

Fourth generation: Defective intelligence, first attack of mania at sixteen, stupidity ending in complete idiocy. Furthermore probable extinction of the family.

Now it is almost certain that this progress in degeneration, by cultivating the hereditary tendencies, might have been made a progress in the reverse direction by a continued effort to overcome and destroy the tendencies. The same may be true of a disease like consumption, the tendency to which is so notoriously hereditary. It might be quite possible for a parent, who had a marked family tendency to consumption, by careful living, to keep it in abeyance; and his success would doubtless influence his offspring. If they, in their turn, were similarly careful, a still diminished liability might be transmitted by them. By such a process as this, repeated through several generations, the disease, which at first threatened extinction of the family, might finally be rooted out.

(3) A parent who may have inherited a robust enough constitution may himself acquire a disease, syphilis, for example, which he then hands down to his child; or by drunkenness or other excesses he may transmit a constitution, if not actually diseased, at least very prone to disease. For instance, it has been found possible to produce epilepsy in guinea-pigs by dividing a certain nerve; and these guinea-pigs, affected by a disease artificially produced, have afterwards given birth to young which were subject to convulsive attacks. So it is that a man by alcoholic excess may be the cause of insanity, idiocy, weak-mindedness, or a tendency to these, in his offspring.

A singular thing in reference to inheritance is, that a peculiarity of structure or character may skip one or more generations, and reappear in other succeeding generations. The father may have it, his children escape, but his grandchildren manifest the same tendency. This is called **atavism**, which simply means a return to the state of the grandfather.

Darwin has pointed out a rule, which he says may be trusted, that "at whatever period of life a peculiarity first appears, it tends to reappear in the offspring at a corresponding age, though sometimes earlier." To some extent this is true of hereditary disease, and might, if widely known, be taken advantage of, so that steps might be taken, before the arrival of the particular age, to avert, if possible, the development of the suspected disease.

It may be well to note a very curious fact, that a mother, who has previously borne offspring, may afterwards have children, by a different husband, *bearing the characteristics of the first.* Thus a widow who marries a second time may, by the second husband, have children strongly resembling the first.

Finally there are other peculiarities which not infrequently "run in families", such as, the disposition to be more strongly or disagreeably affected than usual by certain drugs, like mercury or opium, or less strongly than usual, the tendency to be influenced by the smell of fresh hay or the perfumes of certain flowers, the inability to take, without discomfort, certain kinds of food, such as mutton, or even simple medicines like magnesia, and the tendency to catch any and every disease that may be "going", or great freedom from and indisposition to disease.

Thus, in estimating causes of disease, hereditary influences in their direct bearing, and in their bearing on personal peculiarities, must not be overlooked.

6. **Previous disease** is another great predisposing cause of disease. Of course previous disease may act as a safeguard against the return of the same disease, thus small-pox and some similar affections give immunity from a second attack. On the other hand it is the rule, in very many cases, that once having the disease means always liable to it. Thus it is always the case that a person who has had an attack of quinsy, an inflammation of the tonsils, cannot be exposed for any time to cold or wet without great risk of its return. Erysipelas, boils, the kind of cold commonly called influenza, bronchitis, inflammation of the kidneys, are very troublesome in this way. Further, one disease often produces a liability to another and quite different malady. One of the most common examples is acute rheumatism, the great danger of which is that it may lead to heart-disease, while it may also cause liability to St. Vitus' dance. Again, many kinds of skin disease, bone diseases, throat affections, nervous complaints, diseases of the eye, ear, nose, &c., paralysis, epilepsy, and in fact almost any kind of disease, may be due to syphilis, contracted many years before, and may with difficulty be traced back to their true origin.

In concluding this review of predisposing causes of disease it should be stated generally that the great predisposing cause is, putting it popularly, "*letting one's system get down*". Let a man tax his energies with overwork, let him get depressed in spirits by worry or anxiety, let him, for any time, neglect taking regular and proper diet in sufficient quantity, or indulge in excess, his natural vigour becomes, perhaps not apparently, but gradually diminished, and he loses some of his power of resisting disease, and so is liable to fall an easy prey to some affection which, in his robust condition, passed him by.

In connection with these predisposing causes of disease a word is frequently used which it may be well here to explain. A person may, owing to previous disease or owing to inherited peculiarity, have a strong tendency to a particular affection, in which case he is said to have a particular "**diathesis**", which simply means tendency. Thus an individual who came of a consumptive stock might be said to have the *consumptive diathesis*; so a man might be of the *rheumatic or gouty diathesis.* He need not have had the disease, but simply is strongly inclined that way. The possession by a person of a particular diathesis should never be overlooked.

B. Exciting Causes of Disease.

These include the causes which immediately and directly produce the disease and give to it its character. Thus, in the case of an old woman whose arm is broken by a not very severe blow from a stick, the predisposing cause is old age, which has rendered the woman's bones brittle, and the exciting cause is the stick.

There is a variety of exciting causes.

1. **Mechanical Causes.**—Violence of any kind applied to the body belongs to this class. Mechanical exciting causes may also attack the body *from within.* Thus a gall-stone, which blocks the tube leading from the liver, will cause severe pain, jaundice, and so on, simply from its mechanical obstruction. Stone in the bladder is another example. Again, stoppage of the bowels may be due to

mechanical causes, the blocking of the passage by masses of hardened excrement, or by twisting or narrowing of the bowel. The windpipe may be closed by something that has accidentally slipped in from the mouth, &c.

2. **Chemical Causes.**—These include poisons of all kinds introduced into the body from without. They also embrace the action of substances which may have originated in the body itself, such as waste products, and which the body has failed to expel. Thus the kidneys may fail to expel certain waste materials, and convulsions, or dropsy, result; the liver may be the organ at fault, and jaundice ensue; the lungs may be defective, and attendant want of aeration of the blood, with its consequences of livid features, breathlessnesss, perhaps delirium, may arise.

3. **Vital Causes.**—To this class belong insects such as may infest the surface of the body, skin, hair, &c., and parasites, like the tapeworm and others, found principally in the bowels. These may be the direct exciting causes of acute diseases like convulsions, or slow vague changes classed under general names such as ill-health, general debility, decline.

Much more formidable and far-reaching vital causes of disease are grouped under **Contagia** and **Malaria** (see INDEX), which, being introduced into the body, proceed there to develop and multiply, and set up a series of well-known and well-defined processes, having most marked effects upon the body, those agencies, namely, to which the special fevers and all contagious and infectious diseases are held to be due. What the nature of these contagia and malaria is will be discussed when we come to consider fevers.

Besides the exciting causes mentioned under these three classes, there are others, not easily referred to any of them, which are yet directly active in the production of disease, some of which have been referred to also under predisposing causes. Among them are cold, wet, excess or deficiency of food, unwholesome food, bad air, over-exertion, strains, sexual and other excesses.

The Detail of the Systematic Examination for Disease.

There are two ways of gaining information as to the state of health of a person. The first is by learning from the person himself what are his feelings, and by similar information which he alone can supply, and which another person could not learn for himself; the second is by examining thoroughly the body of the patient, first as to its external form and appearance, and then examining, so far as may be, each organ, individually, by aid of hands and eyes and ears, and any instruments which may be devised to help. The indications of disease, signs or symptoms of disease, as they are called, obtained in the first way, from the patient, are called *subjective* symptoms, and those obtained in the second way are called *objective* symptoms. Most of the objective symptoms can be found by one who knows how, quite irrespective of the patient, without his aid, even though he were asleep or otherwise unconscious, and are therefore more valuable and less liable to produce deception. On the other hand, the subjective symptoms being supplied by the patient's own statement will depend on his intelligence and truthfulness. Pain, for instance, is a subjective symptom; and a patient may complain of most excruciating pain when he has nothing of the kind, but feigns it for a purpose of his own; while swelling is an objective symptom, displacement of a bone is another, which would be evident even on the dead body. The collection of all the facts, of all the symptoms, obtained in both these ways, form the basis on which a decision may be made as to the presence of disease and the kind of disease. The gathering of these facts in order to make this decision is called **diagnosis**, and includes everything in the man's life that can establish a key to the disease. A thorough diagnosis requires also a view of the person's antecedents (his family history), of his personal history, of his social relationships, and of similar circumstances already referred to in discussing causes of disease.

For the knowledge of family tendencies or failings, of illnesses from which a patient had previously suffered, of the patient's social position and habits, of his occupation and so on, often affords the clue to the unravelling of some obscure case of disease.

How does one proceed, it may be asked, to unravel such an obscure case? Let us illustrate by a concrete example: a person knows he is not in good health, though he does not complain of anything in particular. But he has too little energy for work; he is too easily tired; he is nervous and irritable; his sleep is disturbed and unrefreshing; he is losing flesh, and his friends tell him he is not looking well. This state of affairs has not come on quickly within a day or two, or a week or so, but has been of gradual onset, so that he can hardly fix an exact date, but finds he must go back several months in his memory to recall a time when he was, or supposed himself to be, in excellent health. He therefore, presents himself before a physician, able only to state this vague case, and hoping the physician will go into the matter thoroughly to discover whether there is actually anything wrong, and if so what exactly it is.

It is quite true that there are some people who seem only to desire an assurance that they are quite well to go away content. They half hope that the doctor, after hearing their complaint, will make some pretence of examination, feel the pulse, look at the tongue, and after a few questions will, with a slap on the back, and in a jovial voice, assure them they only need a change of air and scene for a week or two to make them "as fit as a fiddle". Every physician has experience of a visitor of this sort, who resents, or seems to resent, or pretends to resent, the wish of the physician to make a careful examination. Sometimes it is because the patient is afraid something really serious will be discovered, and wishes to "hug the dear deceit", that there is not much wrong, a little longer. This is a state of mind quite common in women, and, if a woman harbours the secret fear that she is the subject of a fatal disease, like cancer, it is not matter for wonder that she should delay, as long as possible, to have the dread fact made clear. But very often such an attitude on a patient's part is due to sheer ignorance and thoughtlessness. Many people are so foolish as to suppose that all they have to do is to go to a doctor and tell him what they feel and what they believe to be wrong, and they imagine that if he is of any use at all he will be able, straight away, to order them some medicine which will speedily cure them. They do not see the need of a lot of questions, and they don't see why they should be troubled to remove any clothing to permit an examination to be properly made. Such a man cannot understand how a doctor, who knows his business, cannot tell all about his heart by listening over his waistcoat, and such a woman does not see how her lungs cannot be sufficiently examined through her corsets. This kind of person is, however, getting less common, though they are still fairly numerous.

As a rule, in this twentieth century, however, the person who visits a doctor, under circumstances such as have been stated, wants a careful investigation, and so we proceed to state in a general way how it is conducted.

After particulars have been obtained as to age, occupation, previous illnesses, family history, and so on, the person would probably be asked to state what symptoms he complains of. In the case we have supposed, his difficulty is to state anything very definite except just that he does not feel well, sleeps ill, is losing flesh, and so on. But often he will have some definite complaint, of pain, for instance; in which case he will state where it is felt, what kind of pain it is, at what time of day it comes on, and how long it lasts, and similar facts. When the physician has thus learned from his visitor everything he can state about himself, he proceeds to make his own examination; he starts, that is to say, in his own way to go over his patient, bit by bit, so to speak, examining one organ after another, noting, as he goes, any departure from health.

Now no two men do their work in exactly the same way. No two joiners, set to make a door, will go about the job in precisely the same manner, though when finished each may produce an equally excellent piece of work. So in medicine and surgery every man is entitled to follow his own methods. All we wish to indicate here are the kinds of facts that are looked for, and in a general way the manner in which one looks for them, and the kind of assistance they give. One may divide the facts thus acquired into two great classes:

I. Facts, or signs, or symptoms, gained after a general examination and inspection of the patient's body as a whole, and

II. Facts, or signs, or symptoms, acquired after a more minute examination of special organs.

Now it will very often happen that a more or less general examination will suffice to reveal facts sufficient to indicate to the physician the nature of the ailment from which the patient is suffering, and that all that is further necessary is for the physician to confirm the opinion he has formed, or to exclude the possibility of error, by noting a few special points.

On the other hand, his general examination may have revealed only an isolated fact or two, giving no direct indication of any special disorder, and the more detailed examination may have added little of any conclusive kind. In such circumstances the physician resorts to special and more minute methods of inquiry.

We shall briefly note the kind of facts that are observed in such general and special examinations.

I. General Examination of the Body.

1. **Form.**—The outline of the body, or part of body, such as arm, leg, chest, belly, is looked at, to observe anything unusual in form, colour, size, &c.; and it is well to compare one side of the body with the other. A displacement or

break of a bone will be readily seen by the difference between the two sides; swellings, &c., will also in this way be more evident.

One notes also "pitting" of small-pox, scars of old wounds or abscesses, especially if over glands, in which case they may suggest a scrofulous taint.

2. **Weight.**—In most diseases weight is affected; and if the person can have a note of several weighings, at regular intervals, it will easily be seen whether weight is increasing—generally favourable—or diminishing—generally serious. The following table gives the proportion of weight to height:—

A man of	4	feet	6	inches to	5	feet	0	inches	ought to	weigh about	92	lbs.
"	5	"	0	"	5	"	1	"	"	"	115	"
"	5	"	2	"	5	"	3	"	"	"	127	"
"	5	"	4	"	5	"	5	"	"	"	139	"
"	5	"	6	"	5	"	7	"	"	"	144	"
"	5	"	8	"	5	"	9	"	"	"	157	"
"	5	"	10	"	5	"	11	"	"	"	170	"
"	5	"	11	"	6	"	0	"	"	"	177	"
"	6	"	0	"	——				"	"	218	"

These weights do not include clothing.

There ought always to be slight increase in weight up to 45 years of age.

3. **Proportion of Parts.**—It is noted whether bones, muscles, and fat seem to have their due proportion. Some people "seem all bones:" two men of the same apparent bulk may be very different, the one showing firm, hard muscles, the other being soft and flabby, and evidently more fatty than muscular. These two will stand, obviously, in a very different position as regards disease; the one likely to resist it with vigour and success, the other to be speedily overcome by it.

4. **Colour.**—The skin may be *pale* from deficient quantity of blood or inferior quality, which may arise from improper nourishment (bad feeding, dyspepsia), from loss of blood, or from some disease interfering with the blood (disease of kidney, &c.). Full-blooded persons with a tendency to apoplexy will be florid; *redness* of skin also occurs in fevered states. *Yellowness* is associated with liver disease, and is soonest seen in the white of the eyes. *Blueness* (cyanosis) may indicate disease of the lungs, or may be due to disease of the heart preventing the proper aeration of the blood (p. 323), and is soonest seen on the lips. *Bronzing* occurs in a peculiar affection called Addison's disease.

5. **Dropsical Swellings.**—These most frequently occur soonest at feet and ankles, and can be shown by pressing firmly on the skin with the finger for a short time. On removing the finger, a "pit" remains which slowly fills up. Such a swelling beginning in the face, at lower eyelid, is oftenest due to kidney disease. A prominent appearance of the belly is often due to dropsy.

6. **Expression of Face.**—The face affords most valuable evidence of disease. As regards its colour, see Paragraph 4, **Colour.** In low fevers it may be *dull and expressionless*, in high fevers *flushed and excited*. One side may present a *smooth appearance* without wrinkle, the other may be more than usually *wrinkled and drawn*, indicating paralysis. *Squint* may indicate brain disease; *prominent eyeballs*, goitre.

7. **Attitude.**—The mode of standing, sitting, or disposing of limbs is often

suggestive. For example, a patient suffering from acute inflammation of the belly lies in bed with the knees drawn up towards the head, and resists any attempt to stretch them down; a child with spinal disease high up in the neck will keep head, neck, and shoulders stiff and immovable to prevent pain.

8. **Temperature.**—A point of the utmost importance in detection of disease is the accurate **determination of the amount of heat** of the blood, as indicating the approach or actual presence of fever. This is done very roughly by feeling with the hands the heat of the skin, but this method is never accurate. Often a person will complain of great heat, and seem fevered, when actually the temperature is of the usual amount; while, on the other hand, as in the first stage of intermittent fevers, the person may be shivering and complain of cold, and the skin have all the appearance of cold, when the temperature is actually above what is usual. The only satisfactory way of judging the amount of heat, the degree of temperature, is by means of a thermometer.

The best kind of thermometer is one made for the purpose, called a clinical thermometer (Fig. 2), that is, one for use at the bedside. The figure shows one just about the usual size. It consists of a tube with very thick walls and a very fine bore. At one end is a bulb (*a*) filled with mercury. On the stem, figures are marked, 90, 95, 100, 105, 110. These marks are on the Fahrenheit scale. Suppose the bulb be placed in warm water, the mercury in it expands, and, in order to find room, part of the mercury rises in a thin stream up the bore of the tube. Suppose the fine thread of mercury rises to 90, that indicates that the heat of the water is 90 degrees of Fahrenheit's scale. Between the different numbers on the stem there is a series of markings, one set short, the other longer. For example, between 90 and 95 there are 4 of the longer markings. Now each one of these indicates a degree. So that if the mercury stood at the first *long* mark after 90 it would mean 91 degrees, if at the second, 92 degrees, and so on. Between these long markings are the short ones, each one of which has the value of $\frac{2}{10}$ths of a degree. Suppose the mercury rose to the first *short* mark after 100, it would indicate a temperature of 100 and $\frac{2}{10}$ths in degrees, that is, 100·2 degrees. If it rose to the *second short* mark past the *first long* one after 100 it would show a temperature of 100 and 1 and $\frac{4}{10}$ths, *i.e.* 101·4, nearly $101\frac{1}{2}$ degrees.

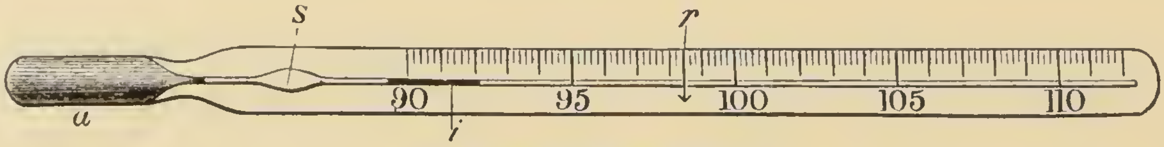


Fig. 2.—Clinical Thermometer

The way to use the thermometer is to place it closely in contact with the skin, allow it to remain there for 5 or 10 minutes, and then see how high the mercury has risen in the tube. The most convenient place is the arm-pit, into which the bulb of the thermometer can be easily placed, and the arm folded down tight over it.

Now suppose an ordinary instrument were used, as soon as the thermometer was taken out of the arm-pit the mercury would at once, owing to the cold air, proceed to run back towards the bulb, and one would not be able to note how high it had risen. Therefore it would be necessary to note how high it had risen while it was still in the arm-pit. This is often not convenient, and in the clinical thermometer what is called an "index" is used. This is a little piece of the thread of mercury (see Fig. 2 *i*) which has been detached from the rest of the mercury in the bulb and left in the tube, and which the little blown-out part (*s*) prevents being shaken back into the bulb. When the mercury rises it pushes up this "index," and, when the mercury recedes, the "index" is left standing at the highest point to which the mercury had reached. In the figure the top of the "index"—it is from the top the readings are taken—stands at 92·2°. When the thermometer is to be used, the "index" should be shaken down as low as 95°, should it happen to be standing above that. To take the temperature, then, see where the index stands, and, if necessary, shake it down as low as 95°, wipe out the arm-pit, bury the bulb in it, and let the arm be folded tightly over the chest and kept so for at least five minutes. Then take out the instrument, taking care not to shake it, and note where the top of the index is. This gives the temperature, which should be noted down. If it is inconvenient to get at the arm-pit the thermometer may be placed in the mouth well back and under the tongue, and kept there, with the mouth as close as possible, for the five minutes. In children the bulb of the instrument is often pushed up into the bowel, the child being held on the nurse's lap, or it may be even asleep in bed. In this case it is necessary first to oil the bulb, or smear it with vaseline. In all cases, indeed, when one wishes to be very accurate the temperature should be taken in the bowel, or "in the rectum" as the phrase is, for the termination of the bowel is called the rectum. In some cases the true temperature cannot be quickly obtained from the skin, and unless it be taken in the rectum one is certain to be misled.

The temperature of the body in health should be about 98·4°, and at this point there is usually an arrow mark on the thermometer (*r*). If the index stands there the heat is normal. There is usually a daily variation, which is slight, the temperature being highest about 9 A.M. and lowest about 3 A.M., but always in the neighbourhood of 98·4°. If the temperature of a person is to any extent above or below 98·4°, it indicates disease, even though the person may have no complaint of any kind. A variation may occur which lasts only a short time and means nothing, but if the high or low temperature is permanent, or frequent, suspicion ought to be aroused.

It is necessary to note, however, that the temperature in the mouth or rectum is always higher than the temperature in the arm-pit or axilla. The normal for the rectum is about $\frac{8}{10}$ths higher than that for the arm-pit, so that, taken in the bowel, the normal temperature is about 99·2°, and if taken in the mouth it is slightly lower. The following table gives the landmarks in temperature:—

Extreme Fever	105° and above	in the arm-pit.
High Fever	104°	
Fever	102·6°	
Feverish (slight fever)	100·4°	
Normal	**98·4°**	
Under normal	97·4° to 96·8°	
Collapse	below 96·8°	

A temperature of 105° is very grave and could not long be endured, and if it go above that, particularly if it shoot above suddenly, it foretells death almost certainly. About 103° is a common temperature in fevers, measles, scarlet fever, and in inflammation of the lungs, while in ordinary colds, influenza, and so on, a temperature of 101°, and even 102°, is frequent. A persistent temperature of 101° or thereby, with nothing apparent to justify it, should make one suspicious of some concealed disease of the lungs, and should lead to a consultation with a physician at once. The "collapse temperature," below 96·8°, particularly if previously the temperature has been high and has suddenly fallen so low as this, forebodes death.

The temperature may be made to vary a good deal by the use of hot or cold baths, but the increase or diminution is only for a short time. The administration of alcohol *lowers* the temperature.

The temperature should be taken twice daily, morning and evening, and every day at the same hour in the morning and the same hour in the evening, so that any comparison between different days may be accurate.

It would be well, therefore, for a nurse or other person, attending an invalid and observing the temperature, to note it down regularly at the particular hour, and, alongside, to place a note of the rapidity of the pulse and the breathing. Thus

	T.	P.	R.
9 A.M.	102·8°	110	27
10 P.M.	103°	115	29

where T. stands for temperature, P. for pulse, and R. for respirations, both of the latter being the number per minute. The manner in which these facts may be recorded on a chart is shown in the section on Fevers.

Thermometers are made which register the temperature with fair accuracy in less than 5 or 10 minutes, the only difference being in the size of the bulb and the thickness of the glass, the quickly-registering ones being thinner and containing less mercury, so that the mass is more quickly heated throughout. They are, on this account, all the more slender, and they are also more expensive. Thus there are "minute clinical thermometers", "half-minute", and so on.

9. **The Pulse** is next in importance to the temperature. It is usually felt at the wrist, and may be found in a straight line drawn parallel from the inside edge of the forefinger across the ball of the thumb to the wrist. It is due to the movement of the waves of blood driven along the blood-vessel by the contractions of the heart. The things to be noticed about the pulse are: (1) *rapidity*, (2) *regularity*, (3) *fulness* and firmness.

(1) RAPIDITY.—(*a*) In the young the pulse is more rapid than in the old. At birth it is from 100 to 120 times a minute; at six or eight years of age from 90 to 100; then it gradually declines till in the adult its rate is *between 65 and 75*; and in the aged it is even slower, though in the very infirm it may become faster. (*b*) The number of beats is increased by food, exercise, by rising from the sitting to the standing position, by heat. (*c*) In women, as an average, it is five beats faster per minute than in men. (*d*) It is increased in debility and fever. (*e*) It is slower—sometimes very slow—in brain oppression, for example, apoplexy, opium poisoning, fracture of the skull, unconsciousness from drunkenness.

(2) REGULARITY.—Irregularity, that is, missing a beat, or two or three beats occurring fast after one another and then slower, is not uncommon. It is sometimes due to actual disease of the structure of the heart, but is also very often of nervous origin, and very frequently is due to flatulence or indigestion. Great smokers have sometimes irregular pulse.

(3) FULNESS.—It should be noted whether the pulse is large and soft—easily compressed—or small and hard. When the former the pressure of blood in the vessel is little, when the latter great. In some diseases of the heart the pulse gives the sensation of small shot passing under the finger.

10. **The breathing** should next engage the attention in the search for disease.

The following table gives the average number of respirations per minute at different ages:—

Age.	Number of Respirations per minute.
Newly-born child	44
1–5 years	26
15–20 "	20
20–25 "	18
25–30 "	16
30–50 "	18

In very old people the number may fall to 12 per minute. There should be one respiration to 4 or 4½ beats of the pulse. If this proportion is seriously disturbed it points to some affection of the chest. In disease the breathing may be increased, as in fever and disease of the lungs, or seriously diminished and laboured, as in apoplexy and other diseases of the brain. In opium poisoning the number of respirations is greatly reduced. In fact this is the seriousness of the case, the difficulty of maintaining the breathing. The writer had a case in which the number was reduced to four per minute, and yet the person was restored. **Stertorous breathing** is breathing accompanied with noise in expiration, and is common where the brain is affected. Another kind of breathing in disease of the brain is when the cheeks are sucked in with each inspiration, and blown out with expiration. **Breathlessness** is common in diseases of heart and kidneys as well as in diseases of the lungs themselves.

II. Special Examination of the Body.

These more or less general points having been noticed, it is necessary to proceed to a more detailed examination with the hope of finding symptoms which will point definitely to the seat and character of the disease. For this purpose it is advisable to proceed in a regular and systematic order, examining, one by one, each organ or set of organs, and noting anything calculated to aid in the search.

1. **The eye** gives information not only by its colour (see **Colour**, p. 37), but by the size of the pupil, the round opening in the centre that looks dark. It usually grows larger with little light, and contracts when light is stronger. In some diseases of the brain—inflammatory, for instance, in water in the head—it is widely open and immovable, while in opium poisoning it is extremely small. Squinting, especially if it comes on suddenly, often indicates disease of the brain.

2. **The Tongue, Teeth, Mouth, and Digestive System.**—The tongue is affected in most diseases. It may be *white and furred*, as in catarrh (common cold), in affections of the stomach, and diseases accompanied with fever. It may be *brown and dry*, as in typhoid and other low fevers; often *red, raw, and glazed* when fever is high. The *scarlet-fever tongue* has red points projecting from the white fur, this is the *strawberry tongue*, so called from its appearance. *Paleness* of the tongue occurs in bloodlessness, and *yellowness* in jaundice. Then in dyspepsia the tongue is frequently furred and flabby, showing at the edges the markings due to contact with the teeth. *Small blisters* on the tongue are frequently due to a bad condition of stomach. In some cases of paralysis the tongue cannot be put out straight in the middle line, but is drawn to one side.

A blistered condition of the gums also will result from stomach disorder; and a bleeding and swollen state of the gums is an occurrence in scurvy.

Rotting teeth, it has been proved of recent years, are an extremely common cause of most persistent forms of anæmia as well as of indigestion. Specially is this found when the person wears a plate of artificial teeth covering decaying stumps, or the roots of teeth whose crowns have been nipped off, the roots being left to maintain the shape of the jaw. These roots, protected from the air by the artificial plate, decay in a peculiar way, becoming depots of yellow purulent material, which taints every morsel of food taken into the mouth, and, carried in the food to the stomach, sets up and maintains there a poisonous form of digestion, irritating the stomach, and besides producing materials which absorbed into the blood affect its quality. The state of the teeth should, therefore, always be looked into, and artificial plates removed for the purpose.

Grinding the teeth is common not in cases of worms only but in other affections of stomach and bowels.

The state of the throat yields much information in many cases. Sore throat and difficulty of swallowing is one of the earliest signs in scarlet fever. Then it is on the tonsils that the white patches of diphtheria make their appearance.

Connected with the stomach are *pain* and *heartburn* as symptoms of dyspepsia. In ulceration of the stomach a burning pain immediately after swallowing, lasting till the food has passed into the bowels, is common. On the other hand, in some forms of indigestion from weakness, and perhaps distension (dilatation) of the stomach, pain is relieved by food. Again, in cases where there is obstruction to the passage of food from the stomach into the bowels, the pain comes on about two hours after food.

The state of the appetite is affected by general diseases as well as by special disease of the stomach. The appetite may be *lost*, as in fevers, or from use of opiates or alcohol, and in congested states of the stomach, constipation, &c. It may be *excessive*, owing to worms, or as in diabetes and various nervous diseases. It may be *depraved*, the person craving for unusual and even disgusting things. This sometimes happens in pregnancy, in mania, and in patients suffering from extreme bloodlessness.

Vomiting is another symptom. When due to deranged stomach it is most frequently accompanied by sickness or nausea. In children between two and seven years of age sudden vomiting, without apparent cause *and not seemingly* *accompanied by nausea*, is suspicious of brain mischief. Rupture causes vomiting frequently, and in some of the worst cases of it the vomit contains fæcal matters from the bowel. In cases of enlarged stomach, due to obstruction between the stomach and bowels, the patient frequently vomits a great quantity all at once, the stomach having retained several meals in succession, and then ejected them all. In diarrhœa, vomiting and purging go together. Blood may be vomited. But blood is not readily recognized as such in the vomit, because its colour is changed by the action of the juice of the stomach, except when an exceptionally large quantity of blood has escaped into the stomach and been vomited too quickly for the change to be effected. In the latter case it is recognizably blood. Usually, however, the vomit containing blood looks like coffee-grounds—the "coffee-ground vomit," or is black as in the "black vomit" of yellow fever. Bile is also changed in colour by passing through the stomach, becoming of a greenish hue.

Usually the vomit tastes sour as it passes through the mouth, because of the large quantity of acid gastric juice, but it may be bitter from bile, or it may be of a sweet taste because of the presence of an unhealthy ferment, to which probably the sickness is due, or it may be offensive, in cases of dilated stomach or obstructed bowel.

Vomiting lasting for any time, therefore, or recurring frequently, should lead one to note carefully—

(1) the relation of vomiting to the taking of food;
(2) the amount vomited at a time;
(3) the appearance of the vomit, whether it is
  (*a*) of little-altered food,
  (*b*) watery, or
  (*c*) glairy with mucus.
(4) the colour of the vomit, whether it is
  (*a*) the colour of the food taken,
  (*b*) greenish or greenish-yellow from bile,
  (*c*) coffee-coloured or black from blood.
(5) the taste of the vomit—
  (*a*) acid, sour, acrid,
  (*b*) bitter,
  (*c*) sweet,
  (*d*) tasteless,
  (*e*) offensive.

The state of the bowels largely determines the condition of the health, and therefore causes of disease are to be sought here, of which costiveness, diarrhœa, and colic are the most common.

Gradually increasing and troublesome constipation in a person who used to be regular should always be investigated, more especially if the person is getting up in life, to make sure that there is no obstruction taking place to the ordinary movement.

The evacuations from the bowel themselves afford often very valuable information in many diseases, and the points to observe regarding them are—

(1) Their amount.
(2) Their colour.
(3) Their shape.
(4) Their general character.

For example, black tarry stools are significant of mixture with blood, white clay-like stools indicate absence of bile, seen most markedly when the bile duct from the liver to the bowel is blocked by a gall-stone. Motions flattened like ribbon, or fine like pipe stems, suggest blocking of the bowel and consequent narrowing of its fairway. Again there is a disease of the inner coating of the bowel which may be determined at once by the discovery in the motion of large quantities of glairy mucus, which in advanced cases is shed in masses like pieces of whitish skin—membranous catarrh of the bowel.

In no department has modern medicine advanced more than in that of diseases of the stomach and bowels. Relief, nay! complete cure, is daily effected nowadays in great numbers of cases of stomach or bowel disease which even a dozen years ago could not be satisfactorily dealt with. This is due not only to the adoption of new methods of treatment, medical or surgical, but still more to the more exact determination of the real nature of the ailment. There is no doubt that formerly a great many different diseases were slumped together under the vague heading "Dyspepsia". It is here one may find illustration of the special methods already referred to as made use of in difficult cases.

In a case of stomach disorder, for instance, the exact nature of which is doubtful, the physician is not content with the story of the patient's symptoms however clear that may be. But he orders the patient, at a given hour, to take a specified meal; an hour and a half or so later he is seen by the physician, who passes into the stomach a soft rubber tube and withdraws, for detailed chemical and microscopical examination, the contents. The stomach is then filled through the tube with water and the quantity it can hold thereby determined. Its exact position can at the same time be decided. Exact chemical and microscopical methods are also employed to investigate the character of the motions. Thus information of great value not otherwise available is obtained to aid in determining the disease.

Comment has already been made (p. 25) on the value of the X-rays in detecting the position of a coin or metallic body that has been swallowed, and similarly the situation of a bullet lodged in the belly could be determined.

3. **In examining the chest** attention should be directed to the heart and lungs. *The place where the heart, in beating, comes in contact with the chest* is usually at a spot about an inch and a half below and to the inside of the left nipple. The place should be noted, as well as the characters of the beat. In some diseases of the heart and lungs the heart is displaced, and the beat is not found in the usual place. Then the *movements of the chest* should be looked to, as to whether they are full and regular, not jerky, as to whether one side moves as much as another, and as to whether, in drawing a full breath, there is a catch (stitch) somewhere

Sometimes the movements will be restricted in one place and unusually marked in another, indicating disease. In inflammation of the lungs the chest may be kept almost stationary, and the breathing performed by movements of the belly. The presence or absence of **cough** and **spit** will give important information, both being severe in bronchitis and inflammation of lungs, while there is no special spit in pleurisy. The character of the spit, white and frothy, gluey and thick, yellow with matter, should be noted; and a microscopic examination will often declare the exact nature of a lung affection.

The value of the Roentgen rays in examining the chest has been already referred to (p. 26). For methods of examining further the state of the lungs by percussion and auscultation see DISEASES OF THE LUNGS.

4. **The belly** should next **be examined.** To examine it properly the person should be lying relaxed in bed, with the head and shoulders slightly raised on a pillow and with a cushion or pillow under the legs behind the knees. This relaxes the abdominal walls. The clothing should then be so arranged that the whole surface of the lower half of the chest, and the whole abdomen down to the groins may be taken in at one glance.

When the belly is exposed, in the way described, the mere behaviour of the patient will often reveal a great deal. If the patient lies stiff and rigid, with the knees well drawn up, and if, when the observer is about to lay the hand on the surface, the patient involuntarily raises the hands as if to ward off the observer, this speaks of pain due to inflammatory mischief, which is aggravated by the slightest pressure; while if the pain is merely of a colicky character pressure usually relieves it, and the patient's own hands will often be found holding and pressing on the surface to give relief.

If one watches the exposed chest and abdomen of the healthy person, lying flat, it will be seen that the abdomen moves regularly and smoothly with the movements of breathing, rising and falling with the intake and output of breath. But when there is disease in chest or abdomen, this is altered. If there is disease causing pain with breathing, or hindering otherwise the play of the chest walls, then they appear to be fixed, and the movements of the abdomen are correspondingly exaggerated. On the other hand, if the disease is in the abdomen, it is held rigid, while the play of the chest, and specially the upper part, is all the more marked.

In some cases of disease within the abdomen, if one sits merely watching the surface, exposed as stated above, now and again one may see a movement of a portion of the surface, as if something were moving within. This occurs in dilated stomach, when the communication between stomach and bowel is narrow, and this is a movement of a part of the muscular wall of the stomach in the endeavour of the stomach to force its contents through the narrowed outlet, and the movement is seen in the upper and middle part of the belly. Similar movement may occur and be visible on other portions of the abdominal wall, and they are usually due to exaggerated movement of a distended loop of bowel when the part beyond it is wholly or partially blocked, and is the violent effort of the bowel to overcome the obstruction.

Merely looking carefully at the abdomen will also show whether the abdominal wall is unduly prominent, as it is when a tumour exists within, or dropsy; or drawn-in as it is in children in tubercular disease of the brain. In children the pronounced "pot-belly" is often associated with disease of the glands. Then if the observer lays the flat of the hand (which must be warm) gently on the surface, moving it gently over the surface, he can feel whether the wall is soft and relaxed, or whether it is hard and rigid all over, or soft on one side and rigid, like a board, on the other. Nothing is so certain an indication of mischief within—probably of an inflammatory kind—as this board-like hardness of the belly wall, and it demands skilled attention without delay. It is often a most significant and serious symptom. Again, while the belly wall may be quite soft and yield easily to the pressure of the hand, it may yet be very prominent and tense, and if the hand lying on it be tapped with a finger of the other hand, it may give a drum-like note. This speaks of distension due to gas, and this gas may be in the bowel only, merely flatulent, but it may be due to gases of decomposition within the cavity of the belly itself, as occurs in certain varieties of inflammation (peritonitis, appendicitis, &c.). By moving the hand, laid flat on the belly wall, from one part to another of the surface, pressing with greater or less weight, the fact of pain may be determined and its locality more or less accurately ascertained. **Prodding must never be employed** by an unskilled person.

Pressing with the fingers in the central line, or a little to the left side, just under the ribs, will be painful when the liver is affected by congestion and other diseases.

5. Under **urinary symptoms** *difficulty in making water*, inability to make water at all, constant dribbling of water (which often occurs not only from want of power to retain the water, but also from retention of water, the bladder being therefore always over-full, and the excess only constantly dribbling away), *pain in making water* owing to gravel, and the place of the pain, &c., all these should be inquired about. In the later stages of fever, particularly in low fevers like typhoid, the patient is unable to make water, that is, retains it, and it should then regularly be withdrawn. Sometimes, as in diabetes, the urine is *excessive in quantity;* in diseases of the kidney it is often *diminished in quantity.* Then its *colour*, and the *presence or absence of sediment*, are important. In jaundice it is highly coloured, of greenish brown, from presence of bile. It is often smoky from presence of blood; while in diabetes it is extremely clear and watery looking. In fever there falls a heavy sediment when the urine cools, which is redissolved by heating it.

By a careful chemical examination of urine, and a microscopical examination of any sediment, most important information can be obtained—information, lacking which, in many cases, no reliable diagnosis could be made.

6. **The Skin.**—Everyone knows what information can be obtained from this source, not only in disease of the skin itself, where each disease has its own special eruption, but in general diseases as well. Thus many fevers have their own *kind of eruption* by which the fever may be distinguished, that of scarlet fever being a general red blush, while in measles spots are raised above the skin.

In some kinds of paralysis the *degrees of sensitiveness of the skin* is important. The *colour* has been already referred to.

The *degree of moisture* of the skin gives valuable aid not infrequently. For instance, the peculiar sour-smelling sweat of acute rheumatism is characteristic, and so are the night sweats of consumption.

The diagnosis of disease, then, is often a very difficult and complicated task, and is properly performed only by a general survey of the body, and a detailed investigation of the different organs, in the manner indicated by the sketch already given. Fuller details are, of course, given under the special diseases.

When a diagnosis has been made, and the character and extent of the disease ascertained, it is often possible to estimate what the course and termination are likely to be. This prediction, as it may be called, of what is likely to happen is called **prognosis.**

The Treatment of Disease.

Just as enormous advance has taken place in the methods of detecting disease, so also has continual progress been made in new methods of treatment.

Every conceivable agency that can by any means aid a sufferer in the struggle against disease is now brought into play.

The most startling advances have been made by surgical methods. It is not so many years since the surgeon was appealed to in the last resort only, to cut out a part or amputate a limb, when he was supposed to deal only with what was more or less on the surface, visible to the eye, or at any rate within reach of the fingers. Nowadays he penetrates into the remotest corners of the body, and even into the recesses of the brain, working miracles of healing where medicine alone were impotent. This has become possible owing first to what are called **antiseptic methods**, which have later given place to **aseptic methods.**

Modern Surgical Methods.

Both these methods are based on the recognition of the fact that the cause of the formation of matter in a wound—suppuration—and thus the failure of a wound to heal, is a living particle of infinitely small size, which settles on the wounded surface, grows and multiplies there, and poisons the part and ultimately the body. All this is explained in Section XXIV. These living particles or organisms abound everywhere, in the air, on the clothing, on furniture, on the skin of the patient as on the hands of the operator, unless they be cleansed by special methods. The very knife which makes an incision through the skin carries on its edge, however fine, this poisonous or septic material, unless special precautions have been taken. It was at first thought that they could by no means be got rid of, and therefore solutions of various substances, fitted to destroy them, were poured over the wound, and the wound was kept in an atmosphere of such septic destroying material till it had healed. The substances which were fitted to destroy these organisms were therefore called anti- (against) septic, and the phrase antiseptic methods of surgery included all the arrangements for destroying this material in the atmosphere in which the patient was to be operated on, on the instruments, dressings, &c., and on the hands of the surgeon and the skin of the patient, and on the wound itself. The benefits of these methods proved to be immediately enormous; blood-poisoning, erysipelas, and such diseases, which used to be the terror of surgical wards in hospital, practically ceased. Nevertheless these methods were not absolutely and always satisfactory, possibly because the very solutions employed to render the operation wound antiseptic were in many cases irritating to the wound.

But the antiseptic method was succeeded by the aseptic. The idea of the word antiseptic is that you cannot hinder the septic organism being about the patient or operator, and therefore you must destroy it on the wound itself; but the idea of the aseptic method is that you can absolutely be rid of the poisonous material, that you can rid the patient's skin of it, the surgeon's hands, his instruments and dressings, and remove it from the room in which the operation is done. When the aseptic surgeon makes his incision, no septic material alights upon it, and when the operation is done, the wound is closed, aseptic dressings are put on, and the wound heals straight away, because all septic material has been banished. Hence the word aseptic (*a*, without).

This method has rendered possible, and with a minimum of risk, operations that could not have been contemplated a few years ago. The aseptic surgeon can to-day open the abdomen, and, through the opening, can bring within reach of his fingers, stomach, spleen, liver, kidneys, and every organ of the abdomen, noting its condition, and prepared to treat in some way any abnormal condition found. In the same way he can enter the cavity of the chest, or lift a portion of the skull and remove some tumour or abscess from the brain.

Modern Medical Methods.

Medicine, as distinguished from surgery, can show no such obvious triumphs. Nevertheless the treatment of disease by medical methods, as distinguished from surgical, has made remarkable progress during the same years that have witnessed the great achievements of surgery. The treatment of disease by the physician no longer begins and ends with the writing of a prescription, and the administration of periodical doses of medicine.

The physician of the twentieth century recognizes far more acutely than his forerunners did that disease is a disorder of life against which all the forces of life tend to struggle, which they tend to resist with all their might. In the struggle against disease, therefore, success will depend upon the skill with which the physician is able to array on his side all these forces of life and of nature. In any serious illness his first concern will be to see that his patient is in healthy surroundings, that his room is kept healthy with fresh air and sunlight, though that does not mean that he lies in a draught or is plagued with the sun in his face. For the same reason to secure scrupulous cleanliness of the patient's person, of his clothing and of his bed, are parts of the physician's care.

Anyone who has read with understanding what has been said in a former part of this Introduction will perceive how important it is that the physician should next give careful and fully detailed instructions as to the food and drink to be given to the patient, the quantities in which, and the times at which, they are to be given. Too often these are left to the fancy of the patient or the notions of the friends in attendance. Surely it follows from what has been said about the blood being a stream of raw material, carrying to the muscles and other organs the means of restoration and repair, and about that stream being replenished from food-stuffs, elaborated in the digestive organs, that a most potent means of influencing any disorder, going on in any part of the body, is afforded by what is given the patient in the shape of food and drink. Only the person, therefore, who has some knowledge of the real nature of the disorder is competent to determine what the food and drink should be in each case.

In the next place, if it is important that waste substances should be rapidly removed from the healthy body, surely it is of even more importance that, in the body already a prey to illness, poisonous waste substances should not be allowed to accumulate. But we have seen that there is a great variety of waste substances to be removed, and various organs provided for the purpose. Therefore, again, it is only the trained physician who is able to determine, in each particular case, by what means the removal of waste from the sick man's body can be most appropriately hastened. Suppose, for instance, a patient suffers from an inflammation of the kidneys. The kidneys are practically the only organs whose business it is to remove one special kind of waste from the body, namely the waste of meaty food-stuffs. Think how absurd it would be to set to severe manual labour a man just recovering from a broken right arm, or an arm just getting better from severe bruising. But to give a man with inflammation of the kidneys a diet consisting largely of strong beef-tea would be to be guilty of the same cruelty and stupidity, because this beef-tea is rich in the materials whose waste it is the kidneys' business to remove, and the kidneys' business alone. To give such a diet would be to throw upon these organs, weakened by disease, a severe strain, under which they might well again break down.

In the treatment of disease indeed it is one of the first and most important duties of the physician to regulate what is introduced into the body by the mouth, and to consider the most judicious way of clearing away waste.

When the physician has done these things for his patient, namely:

(1) Has seen to the healthiness of his room and person and bed,
(2) Has given detailed instructions as to his diet and drink,
(3) Has taken measures to secure the proper removal of waste by the bowels, skin, kidneys, and lungs,

he has already done a great deal to marshal in his favour, in the fight against any disease whatever, the vital natural forces that war against disease. Indeed it would be perfectly true to say that, in very many grave disorders, to do these things judiciously and effectually is to do nearly all that is necessary, and to know how to do it in each particular disease, and in the circumstances of each particular patient, calls for a wide knowledge of the processes of life and the ways of disease, as well as tact and knowledge of men.

It is only after these things have been done that the physician proceeds to consider whether, by the use of some drug, or combination of drugs, he can modify the disease or help to check it, or can act upon any organ to strengthen or assist it to bear up against the strain the disease throws upon it. He may, for instance, be able by drugs, or other means, to keep fever within bounds, to subdue or abate inflammation, to strengthen the heart, or allay its excitement, to soothe or quiet the irritable stomach, to allay nervous irritability, to help to sweep out of air-passages phlegm threatening to clog them, to quicken the activity of the skin, to secure sleep, and so on.

Up to the last quarter of the nineteenth century the remedies employed for these special purposes were derived from the metals and their salts, iron, antimony, arsenic, lead, and so on, or from plants, such as digitalis, belladonna, squill, the poppy, cinchona, and so on, in the form of infusions or tinctures or extracts of leaves, root, bark, &c. Any progress made consisted in the discovery of remedial effects, in particular diseases, of such substances not previously employed in medicine. But the end of the nineteenth century was marked, so far as the medical treatment of disease was concerned, by two important discoveries. The first of these was that extracts of certain organs of animals produced astonishing results in some diseases. The chief illustration of this is the use of the thyroid gland of the calf or sheep or pig in the disease represented in Plate II., Myxœdema. At first pieces of the raw gland were administered, but now the dried substance is used in powder or tabloid or capsule, or a glycerine extract is made. For similar purposes, the thymus gland has been used, and other organs also, the brain among them. The red marrow of bone, for instance, and the red colouring matter—hæmoglobin—extracted from blood have proved extremely useful in diseases of the blood.

The second important discovery was that some diseases, due to an organism, could be controlled by injecting into the patient's body a preparation from the blood of an animal in which the disease had been artificially produced without the animal succumbing. This is called the **serum treatment of disease**, and in diphtheria and certain cases of blood-poisoning it has saved thousands of lives that otherwise would have been sacrificed. A serum for the treatment of tubercular diseases—the consumptive diseases—was prepared by the great German pathologist, Koch, but it has failed to realize the expectations of its producer. Some progress has, however, been made in the production of sera for the cure of typhoid fever, plague, and snake-bite, which are referred to in the body of this work.

In another direction the medical treatment of disease has made great progress during the last twenty-five years, namely in the employment as curative agents of the great natural forces of water, heat, light, and electricity. Baths have, of course, been long used for the treatment of gout, rheumatism, and skin affections, but scientific methods of study have yielded results which have enormously increased the uses of water in the internal and external treatment of disease. The treatment of certain forms of heart disease by Nauheim waters is a case in point. The cure of lupus by the Finsen lamp, the treatment of cancerous and other growths, and skin affections, by the Roentgen rays, the treatment of rheumatic affections by the heat and light bath, and of nerve diseases by electric currents of high frequency are all illustrations of this progress.

All these developments in the methods of medical treatment of disease have given rise to new technical terms, which the following summary of methods of treatment will enable the reader to understand:—

The treatment of disease (by whatever means) is **Therapeutics** or **Therapy.**

Treatment by regard to the healthiness of surroundings is **Hygiene.**

Treatment by means of diet is **Dietetics.**

Treatment by means of drugs is **Pharmaceutics.**

The new departures in drug treatment are often spoken of as the **Therapy of Animal Extracts** and **Serum-therapy.**

Treatment by means of physical agents, such as light, electricity, &c., is spoken of as **Physico-therapy.**

The various branches of physico-therapy are treatment by water—**Hydrotherapy**; or if the use of water is restricted to baths, **Balneo-therapy.**

Treatment by means of heat, **Thermo-therapy.**

Treatment by means of light, **Photo-therapy.**

Treatment by means of electricity, **Electro-therapy.**

Treatment by means of apparatus for muscular movements, **Mecano-therapy.**

Preventive, or, as it is called, **prophylactic** treatment, implies the employment of means to ward off a threatened attack of disease. For example, a man who was living in a marshy district and took quinine regularly would be adopting preventive treatment against ague; and the use of lime-juice on board ships, where salt meats are common, and fresh meats and vegetables not attainable, is to prevent the appearance of scurvy.

Palliative treatment is employed to lessen the pain, discomforts, or severity of a disease that cannot be cured, or that must be allowed to run its course. This treatment in a case of very painful cancer would consist in giving opium or morphia, or other drugs, to relieve the pain. A person dying of consumption could have palliative treatment that might reduce for a time high fever, check night sweats, &c., though it might have no perceptible effect on the progress of the disease. Palliative treatment means placing the system under the best condition in the circumstances.

Specific treatment consists in giving a certain prescription for a particular set of symptoms, without knowing how the prescription acts, on the ground of some authority. Salicylate of soda might be counted a specific for acute rheumatism, or, better, mercury for syphilis. "Specifics succeed, but it is not known why."

Expectant treatment might best be explained by the phrase "stand by". There are many diseases which it is impossible to cure, whose progress cannot be arrested, which must be allowed to run their course. All that one can do is to adopt the general treatment as to diet, &c., and then to "stand by", that is, to watch that nothing new arises to interfere with the simple running of its course by the disease, that no complication occurs, or, if it threatens, to endeavour to arrest it. Thus typhoid fever cannot be cured. Once it has begun, it must be allowed to go on till its close, but before that close occurs the patient may run the risk of dying of exhaustion. The person who is watching ought to beware of this and take steps to meet and prevent it, if possible. Again, congestion of the lungs may occur, and this, too, can be dealt with.

In the following sections there will be considered the various organs of the body as they are associated together in groups or systems. One group or system of organs will be taken up after another, each one having a special section devoted to itself. In each section the same order will be followed, viz.: (1) the **Anatomy**, that is, the structure or make of the organ, will first be discussed, and the **Physiology**, that is, the purpose, duty, or function which the organ, or the group of organs together, ought to perform, will be considered; and (2) the **Diseases and Injuries** to which the organs are liable, with their symptoms and appropriate treatment, will be examined.

SECTION I.

THE ELEMENTS OF THE HUMAN BODY.

Protoplasm and Cells: *Squamous, Columnar, Ciliated, Globular, Pigment.*
Epithelium: *Its Varieties and Functions.*
The Connective Tissues: *White Fibrous, Yellow Elastic, Cellular or Areolar, Adipose Tissue or Fat.*

PROTOPLASM AND CELLS.

The ultimate elements of which the body is composed consist of masses, microscopic in size, of a living material called **protoplasm.** In its simplest form, protoplasm is a homogeneous-looking substance, semi-fluid, without apparent differentiation of parts. It may also appear studded with fine or coarse granules, or exhibiting a fine or coarse, more or less irregular net-work. Often it exhibits little spaces, vacuoles, filled with fluid. In the living state it possesses the power of spontaneous movement, evinced by change of form. Thus at one moment the little mass is more or less spherical, then it becomes irregular in outline by one or more processes of its substance being pushed out. Moreover, by pushing out one process in one direction and retracting another, it can change its place (Fig. 3). Now such minute masses of protoplasm are found forming the whole substance of certain microscopic living things. The **amœba** of stagnant pools is such an organism, living an independent life, growing by enveloping with its processes suitable particles in the water with which it comes into contact, building them up into living protoplasm like itself. The material fit for its nourishment it builds up, not at a bound but in various stages, and as a result of its activity waste substances are produced. Thus in such a little mass of protoplasm, there are found not only the substances of which the protoplasm properly consists, namely, proteids chiefly, and also carbo-hydrates, fats, and salts, but also other substances, in but not of the protoplasm, lodged in the meshes of its net-work or in vacuoles, some of which are in process of being built up into living protoplasm, while others are the waste products of its activity. Now while there are found, in the lowest realms of animal life, organisms consisting of nothing more than has been described, there are others similar to them, which possess a small body in the interior called **a nucleus.** This is spoken of as **nucleated protoplasm.**

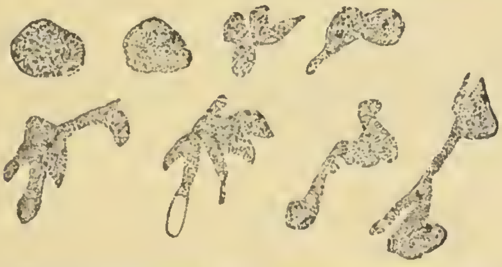


Fig. 3.—White Blood Corpuscle. Its successive changes of shape. Highly magnified.

When the animal body is carefully examined, in all the tissues there are found masses of nucleated protoplasm of various sizes and shapes. In all essential features they resemble the structures described. Such bodies are called **cells.** In many of them the nucleus is finely granular or reticulated in appearance, and on the threads of the mesh-work may be one or more enlargements, called **nucleoli.** In some cases the protoplasm at the circumference of the mass is more or less modified, condensed, so that the appearance of a limiting membrane is produced, or **cell-wall.**

A cell, then, is a mass of nucleated protoplasm, the nucleus may show a nucleolus, and the cell may be limited by a cell-wall. The only essential thing, however, is the living ever-changing protoplasm; and one must ever bear in mind the double process that, while it lives, goes on within the protoplasm, the process of building up lifeless into living stuff, and the process of breaking down by which waste is produced.

Moreover, the amœba we have spoken of multiplies by division, each half thus formed going free as an independent organism, in due time also dividing into two independent organisms. If the animal body be studied in its development, it is found to originate from a single mass of nucleated protoplasm, a single cell, the ovum or egg (Fig. 4) showing both nucleus and nucleolus. From this single original cell two are formed by division, then four, and so on till a little mass of cells is produced, and from these, by further growth and development, the animal body with all its various tissues is evolved. This view of the development of living structures was first put forth by two Germans, Schleiden and Schwann, in 1838, and was termed the **cell-theory**.

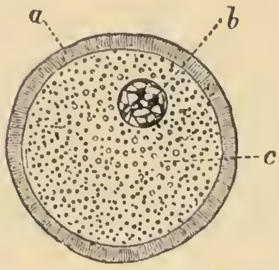


Fig. 4.—Diagrammatic Representation of Ovum.

a, Zona pellucida, or limiting membrane; *b*, nucleus with nucleoli; *c*, protoplasm of cell with numerous granules and fatty globules. (From Klein.)

Many fully-formed tissues consist chiefly of cells, notably the liver (see p. 200). In many others the cells have been modified to form fibres, such as tendon, muscle, nerve, &c. In the blood are found bodies, the white blood corpuscles, exhibiting all the characters of the amœba (Fig. 3).

Even such hard and dense structures as bone, gristle, and tooth are formed originally from and by the agency of cells.

The cell is therefore the histological unit of the body. By association, combination, and modification of cells the body is built up. It may also be safely asserted that if the true character of the changes going on in living protoplasm, the building up and the breaking down process, were accurately understood, the secret of life would be laid bare.

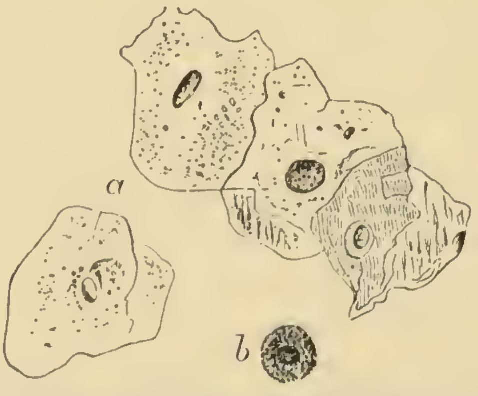


Fig. 5.—*b*, Globular Cell from Salivary Gland, with *a*, Squamous Cells from the Mouth. Highly magnified.

Cells vary in size, some being only $\frac{1}{3500}$th of an inch or less in diameter, whilst the largest, the *ovum*, is only from $\frac{1}{400}$th to $\frac{1}{120}$th of an inch in breadth. They also vary greatly in form, as may be seen from the accompanying figures.

The typical cell is more or less **globular** in form, and such are found in glands. A drop of saliva from the mouth will usually exhibit, besides large flat cells, globular cells from the salivary glands.

There are also **columnar cells**, in which the cells are closely ranged side by side (Fig. 6).

Another form is called **ciliated columnar**, in which the columnar cells have delicate prolongations—cilia—from the free surface (Fig. 6). These cilia are, when the cell is living, in constant movement, and, when observed under the microscope, present the appearance of the passage of a wave, as is seen when the wind blows over a corn-field.

There are cells of **spindle** shape, cells with numerous branching processes, **branched or stellate cells**, cells flattened into a pavement form, **squamous or pavement cells** (Fig. 5), **polyhedral** cells, and so on.

Besides being thus classified according to *shape*, cells may be designated according to *contents*. Thus **fat** cells and **pigment** cells are spoken of, the former being filled with oil, so that it appears as a mere sac of oil, the latter being loaded with dark-coloured granules.

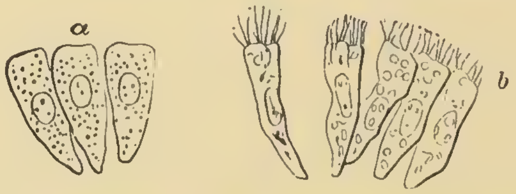


Fig. 6.—*a*, Columnar Cells; *b*, Ciliated Columnar Cells. Highly magnified.

Moreover, cells may be described according to their function, or situation, or tissue in which they are found, as epithelial cells, blood cells, gland cells, nerve cells, connective-tissue cells.

The **functions** of cells have been already partly indicated. They manifest vitality in various ways: (1) absorption of matter; (2) transformation of the same either into protoplasm or some material formed by the cell, such as fat or pigment (colouring matter); (3) separation of waste matters of no further use to the cell (excretion); (4) growth or increase in size and development of parts by taking up new matter; (5) development of new cells or descendants which succeed the old ones; and (6) special properties, such as that of changing their form or contracting, or that of nervous activity, as shown by the cells of the nervous system. Each cell has a life of its own. Some live for from 12 to 24 hours, as is likely the case with many of the cells lining the alimentary canal; others may live for many years, as in cartilage or gristle and bone. In glands they are constantly engaged in separating various matters from the blood, and altering or elaborating these to form new substances, to be made use of in the body or expelled from it. Thus the cells of the liver form the bile, those of the kidney separate certain substances from the blood, which are cast away in the urine, while those of the salivary glands and of the glands of the stomach and pancreas form the juices by whose agency food is digested.

EPITHELIUM.

Cells are associated and combined in various ways to form simple tissues. Such a simple tissue is called an **epithelium**, and the cells are called **epithelial cells**. The cells are united together by a very small amount of a cement substance. The cells forming an epithelium may be globular, squamous, columnar, or ciliated, and so squamous epithelium, columnar epithelium, ciliated columnar epithelium, and so on, are spoken of. Moreover, the cells forming an epithelium may be in a single layer only, or may be several layers deep. In the former case the epithelium is said to be **simple**, in the latter case **stratified**. It is, then, easy to understand what is meant by **simple squamous** epithelium, and what by **simple columnar** epithelium, and what by **simple columnar** ciliated epithelium. In each case what is meant is a tissue formed of a single layer of cells, but in the first the cells are squamous, in the second columnar, and in the third ciliated columnar. Then there is **stratified squamous, stratified columnar,** and **stratified columnar ciliated** epithelium. In the case of stratified epithelia it is the character of the uppermost layer of cells that gives the designation. So that, of the three last phrases, the first means a tissue formed of several layers of cells of which the uppermost is squamous, the second signifies a similar structure, the uppermost layer being columnar, and in the third case the top layer is columnar and ciliated. Now such epithelia are found on the whole surface of the skin, lining the mouth, throat, and whole length of the alimentary canal, and all canals communicating with it, lining the air-passages and recesses of the lungs, the nostrils, canal of the ear, surface of eyelids and eyeballs, lining the tubes and recesses of glands, lining all the closed cavities and tubes of the body, &c., and epithelial structures form the essential parts of the terminal organs of the senses.

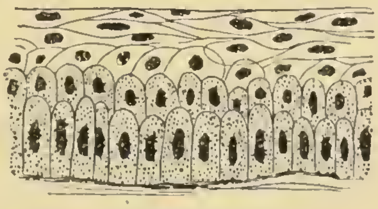


Fig. 7.—Stratified Squamous Epithelium (Klein). Highly magnified.

Functions of Epithelium.—Such structures may be divided, as regards their function, into two main divisions. One set of them are obviously chiefly protective in character. The layers of epithelium which together form the epidermis, or superficial layer of the skin, have little beyond such an office to discharge. So is it with the cells covering the mucous membrane of the mouth, and those lining the inner surface of the eyelids and front of the eyeball, of which Fig. 7 is a representation. A similar duty belongs to the epithelium lining the air-passages and air-cells of the lungs. Epithelia which discharge so inactive a function are commonly formed of squamous or short columnar cells, and if the situation they protect be much exposed, they are generally stratified. The second great division of epithelia consists of those whose cells are formed of highly active protoplasm, and are busily engaged in some sort of secretion. Such are the cells of glands—the cells of the salivary glands, which secrete the saliva, of the gastric glands, which secrete gastric juice, of the intestinal glands, the cells of the liver, the cells lining the tubules of the kidney, the sweat glands, and so on. Such active epithelial structures are usually formed of a single layer of cells, which are more or less globular in form or long columnar.

Of ciliated epithelium it is necessary to say a further word. The cilia are delicate prolongations of the protoplasm of the cell. They execute a rapid whip-like lashing movement as often as ten or more times a second, and the movement may be quickened or slowed by favourable or unfavourable circumstances. All the cilia move in the same direction. In the case of the respiratory passages this serves to sweep mucus up the passages; and in other canals a similar valuable office is filled by the ciliated epithelium.

THE CONNECTIVE TISSUES.

Under this term are grouped certain tissues which to all outward appearance vary greatly from one another, but which are all produced in the developing body from the same parts, and act as packing or supporting structures.

Under certain circumstances one of these tissues may be substituted for another, and in certain situations one merges into another. The following is a list of such tissues:—

- I. **Connective Tissues Proper:**
  - 1. **White Fibrous Tissue.**
  - 2. **Yellow Elastic Tissue.**
  - 3. **Adipose or Fatty Tissue.**
  - 4. **Areolar or Cellular Tissue.**
  - 5. **Adenoid, Retiform, or Lymphatic Tissue.**
  - 6. **Mucous Tissue.**
- II. **Cartilage** (commonly called Gristle), see p. 64:
  - 1. **Hyaline Cartilage.**
  - 2. **White Fibro-Cartilage.**
  - 3. **Yellow Fibro-Cartilage.**
- III. **Bone** and **Dentine** of Tooth (see pp. 57 and 196).

All of these tissues consist of three elements, the proportions of which vary in each tissue, namely, (1) a ground substance or matrix, (2) cells, (3) fibres. The ground substance is best seen in hyaline cartilage (p. 64), where it is transparent and glassy looking, but in the connective tissues proper it is in small amount, and is obscured by the mass of fibres. In bone, and in tooth, this ground substance is infiltrated with salts, which give the bone its hardness and make it so seemingly different from the other tissues. In the connective tissues proper the cells are called **connective-tissue corpuscles**, in cartilage they are called **cartilage cells**, and in bone, **bone corpuscles.** The fibres are of two kinds, one exceedingly fine, transparent, and running a wavy course in bundles—fibres of **white fibrous tissue**, the other, coarse, yellowish, and elastic—fibres of **yellow elastic tissue.**

White Fibrous Tissue.—This tissue consists of bundles of very delicate fibrils. In each bundle the fibrils run a more or less parallel course, though wavy. The bundles are bound together by a small amount of cement substance. Associated with them are the connective-tissue corpuscles, irregular masses of nucleated protoplasm, often branching, but determined as to shape by the pressure exerted on them by the bundles. They lie on the bundles, in minute passages between them, when the bundles run parallel as in tendon; or they lie in spaces, inclosed by the bundles, when these cross to form a felt-work, as in subcutaneous tissue, the loose tissue under the skin. On boiling, white fibrous tissue yields gelatin, and on the addition of a dilute acid the bundles swell up and become cloudy and gelatinous.

Now this tissue is found forming part of various structures, skin, tendon, membranes, loose tissue between and over muscles, beneath skin, &c.; and in these different situations the bundles are variously disposed, parallel in tendon, crossing and recrossing in skin and intermuscular tissue.

Yellow Elastic Tissue (Fig. 8, 2).—The fibres which form the main portion of yellow elastic tissue are much stronger and coarser than those of white fibrous tissue. They are yellowish, and tend to split and curl up at the ends. They possess a high degree of elasticity. It is these fibres that confer elasticity on the skin, and on the coats of blood-vessels. This tissue is the main component of the ligamentum nuchæ, the broad ligament in the back of the neck of large quadrupeds for the support of the heavy head. It does not yield gelatin on boiling; acetic acid has no effect on the fibres, and cells are few in it, if any.

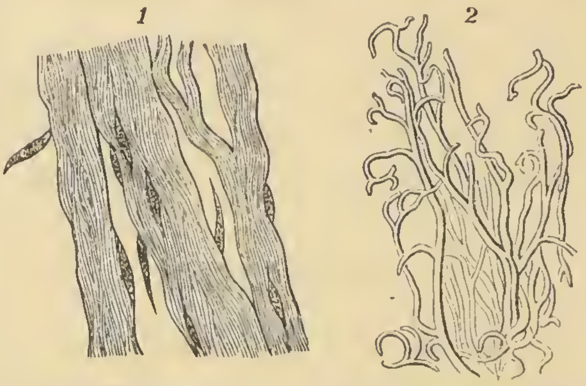


Fig. 8.—Fibres of (1) White Fibrous and (2) Yellow Elastic Tissue. Highly magnified.

Cellular or Areolar Tissue.—This is a compound tissue made up of bundles of white fibrous tissue interlacing and crossing one another to form a mesh-work. Numerous elastic fibres are present, conferring elasticity. The two kinds of fibres are easily distinguished, under the microscope, by adding dilute acetic acid, when the white fibres swell up, become transparent, and the unaffected yellow fibres are revealed. The interlacing bundles inclose little spaces or areolæ, hence the term areolar or cellular. Attached to the bundles or lying in the spaces are connective-tissue corpuscles. There are also other cells, identical with white blood corpuscles, which have probably found their way, by amœboid movement (p. 53), from the blood-vessels abounding in the tissue. It is a tissue found in large quantities under the skin, covering the muscles, the blood-vessels, and nerves, and in various parts forming a kind of protective covering for delicate and important organs. It is because of its general distribution, and because of its binding various structures together, that it is called connective. The little spaces are filled up with fluid that has oozed out of the blood-vessels.

Adipose Tissue or Fat.—This is a simple modification of ordinary connective tissue. It contains fibres of white fibrous tissue, forming a mesh-work in which fat cells are embedded. These fat cells are round or oval, and consist of ordinary connective-tissue cells, in which oil drops have accumulated till the cells resemble little envelopes or sacs filled with oil. The oil may be removed and used up in the body, and then the cells are once more ordinary connective-tissue cells. Adipose tissue forms a considerable layer beneath the skin, covers various internal organs, and is found in the marrow of bones and elsewhere. It is protective, in the sense of acting as a packing agent between organs; and it prevents the heat being carried off too quickly from the body, as it is a bad conductor.

Adenoid Tissue is described on p. 277.

Mucous Tissue.—This is a tissue that is found chiefly in the early stages of development. It subsequently undergoes changes to ordinary connective tissue. It consists of numerous large branching connective-tissue cells, lying in a clear homogeneous semi-fluid mucous substance.

BONE, MUSCULAR, AND NERVOUS TISSUE.

It would complete our general view of the simple elements of which all the tissues and organs of the body are made up, if we were here to consider these other three tissues. For just as a house is built of stone, brick, mortar, wood, slate, &c., so the whole complex body is built up of simple cells and fibres modified in various ways. But it will be more convenient, if less logical, to consider the elements of bone, muscle, and nerve in sections devoted to themselves.

SECTION II.

THE BONES AND JOINTS.

THEIR STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Bones:

Microscopical Structure and Chemical Constitution—Periosteum, Endosteum, and Medulla.

The Skeleton: Head—Cranium, and Face; Trunk; Vertebral Column, description of vertebræ; Thorax; Upper and Lower Extremities.

The Joints:

Structures that enter into the formation of a joint—Bone, Cartilage, Synovial Membrane, Ligaments.

Kinds of Joints: Imperfect; Perfect—(1) Ball-and-Socket, (2) Hinge, (3) Pivot, (4) Shifting.

Kinds of Movements: (1) Angular—Flexion and Extension, Adduction and Abduction; (2) Coaptation; (3) Circumduction; (4) Rotation.

THE STRUCTURE OF BONE.

Bones consist of an earthy or mineral part and an animal part. If a bone, say a rib of an ox or sheep, be steeped for several weeks in dilute hydrochloric acid, the mineral matter is dissolved out by the acid, and there remains the animal matter. It retains perfectly the outward form of the bone. It is no longer hard, however, but soft and flexible. On the other hand, if a bone, say the knuckle from a joint, be put into a clear fire, the animal matter is slowly burned away, and only the mineral remains. The bone, by the burning, first becomes black, and then, as the last trace of animal matter disappears, it becomes pure white. The earthy matter also retains perfectly the shape of the bone, but is very brittle, and liable, at the slightest touch, to crumble to dust. The earthy matter forms about 70 of every 100 parts of the bone, and the animal or organic matter about 30 of every 100, less than one-third. The animal matter is a substance, called ossein, which yields gelatin on boiling; and the earthy consists of phosphate and carbonate of lime, phosphate of magnesia, and chloride of sodium (common salt). In childhood bones contain a larger percentage of animal matter, therefore they are flexible and more liable to bend than to break; while in old age they contain a greater percentage of mineral matter, and therefore are more brittle and easily broken.

Usually when a bone is sawn through it is found to have a shell of hard, compact bone outside, and inside the plates of bone are less closely packed, spaces being left between, giving a spongy look. This spongy bone is called **cancellated**. Fig. 9 shows this very well. A long bone has in its centre a cavity called the **medullary canal**, filled with a soft, reddish, pulpy substance, consisting largely of fat cells, and called the **medulla or marrow**.

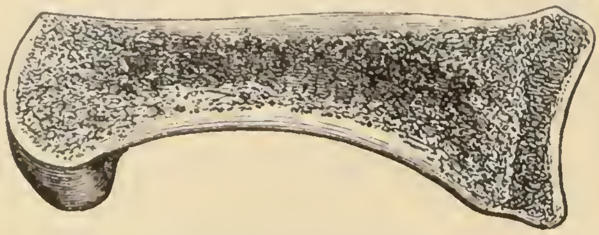


Fig. 9.—Showing dense bone outside, spongy bone within.

Bones are usually classified as *Long*, or *Cylindrical*, such as the long bones of the arm or leg, *Short*, or *Irregular*, such as the small bones of the wrist and sole of the foot, and *Flat*, or *Tabular*, such as the bones of the skull.

Bone is completely covered outside by a dense fibrous coating called the **periosteum**, which is richly supplied with blood, and plays a chief part in the growth of bone. The cavity in a bone is also lined with a similar membrane called **endosteum**, also rich in blood-vessels.

The bone itself seems so dry and hard as to have no moisture within it, nor any blood-supply; but this is not the case, for blood-vessels pass into it from the periosteum through minute openings, and most long bones have besides a special artery (**nutrient artery**) entering them to carry a due supply of nourishment. If a very thin slice be taken from across a bone and examined under a microscope, magnifying about 300 diameters, an appearance is presented like that shown in Fig. 10 B. Little openings (*a*, *b*) are observed, and round them are ranged rings of bone (*c*, *d*, *e*), with black bodies (*f*) in them, from which fine dark lines branch out. The openings are canals cut across, called **Haversian** canals, after Havers, who first described them; the black bodies are spaces, called **lacunæ** (little lakes), in the bony plates, while the fine dark lines are very narrow canals which connect the lacunæ with one another and with the Haversian canals. The narrow channels are called **canaliculi**. A, of the same figure, shows a section taken lengthways, by which the Haversian canals (*a*, *b*) have been opened up, not cut across, and are seen branching and communicating with one another. Now, in these Haversian canals blood-vessels run; the lacunæ contain little masses of a jelly-like material—living protoplasm—processes from which pass along the canaliculi. C, of the figure, shows a lacuna (*a*), largely magnified, with its living mass of protoplasm (*b*). Thus bones have not only a large blood-supply obtained from the nutrient artery, and from the periosteum covering the outer, and the endosteum lining the inner, surface, but contain innumerable little cells of living material, which are capable of drawing from the blood the sort of food they require, and thus of maintaining a constant net-work of nourishing channels through the whole bone.

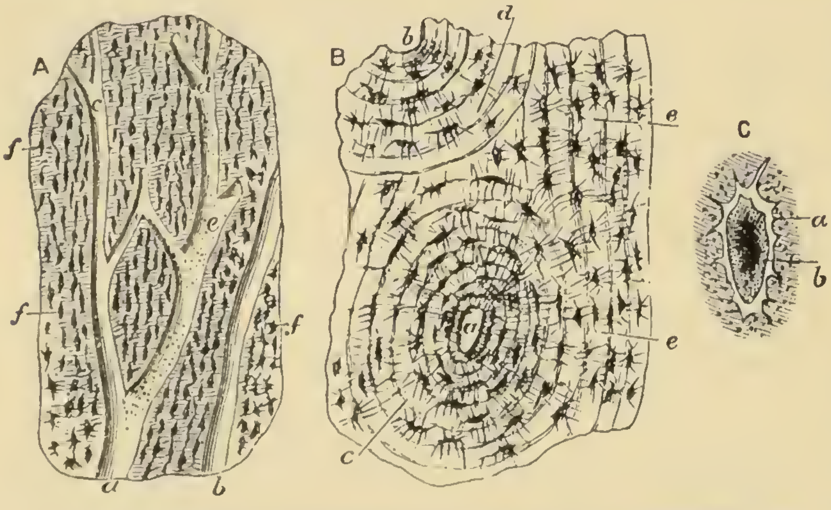


Fig. 10.—Microscopical appearance, A, of section of bone lengthwise, and B, in cross section. C, A bone cell.

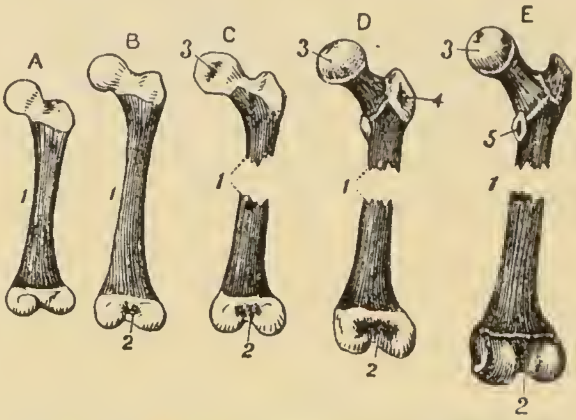


Fig. 11.—Centres of Ossification of the Thigh-bone.

Early in the life of the child, months before it is born, there are no true bones in its body, their place being occupied by cartilage (gristle). The masses of cartilage have, however, the shape of bone, and it is out of them the bones are developed. Take such a one as the thigh-bone; it is found that shortly before birth only the shaft has become true bone, the two extremities being still made of cartilage (Fig. 11, A). Just at birth a small deposit of earthy matter is found in the lower end (B 2), which goes on extending. At one year of age a second deposit is seen in the upper end (C 3). These little deposits, from which the bone forms, are called **centres of ossification**. The bone formation goes on from these centres till the ends are quite bony, and cartilage exists only at the place of junction between the shaft and the two extremities. The two ends are called **epiphyses**, and may readily be separated at this stage from the shaft. This is an accident which sometimes happens to children, and since it is at this point of junction that the principal growth in the length of the bone occurs, such an accident may seriously interfere with the growth. The union between shaft and epiphyses does not take place till maturity, when further growth in the long direction ceases. Bones increase in thickness by growth from the inner surface of the periosteum. If, by accident or disease, the periosteum be stripped off, no increase in thickness can take place, and the surface of the bone, deprived of its nourishment, will die; and, for a like reason, destruction of the inner lining membrane would impair the vitality of the inner surface. On the other hand, the periosteum may be kept in a higher state of activity than usual by constant irritation, as in chronic inflammation. The result will be increased formation of new tissue and thickening of the bone. See DISEASES OF BONE.

THE SKELETON.

(Plate IX.)

The skeleton forms the framework of the body, and is composed of bones united by joints, in many cases plates or pads of gristle being interposed between the opposing bones to permit of movement, the union being strengthened by fibrous bands, which bind the one bone to the other.

The skeleton is divided into **head**, **trunk**, and **limbs**, and is made up of more than 200 bones.

THE HEAD.

This includes the part inclosing the brain, called **cranium**, and the **face**, the former containing eight bones, and the latter fourteen.

The eight bones of the cranium are the **frontal**, two **parietal**, the **occipital**, two **temporal**, the **sphenoid**, and the **ethmoid**.

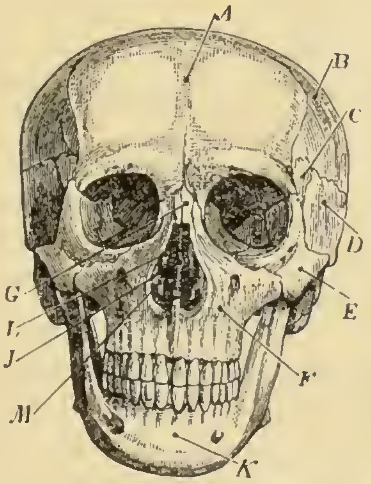


Fig. 12.—The Head, viewed from before.

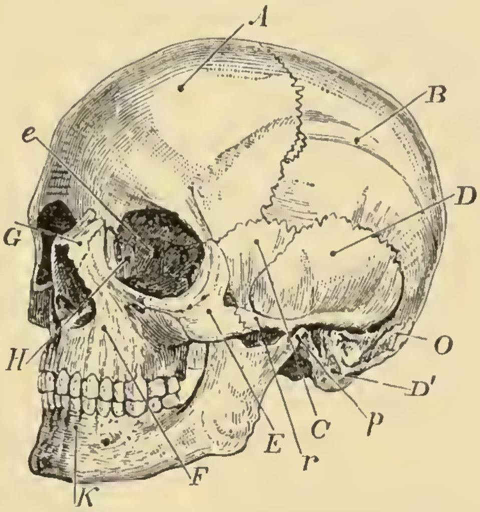


Fig. 13.—The Head, viewed from the side.

The **frontal** (Figs. 12 and 13, A) forms the forehead and part of the vault of the skull, as well as part of the roof of the sockets for the eye-balls (called the orbits). In children the frontal bone is in two parts, by a division passing down the middle. The **parietal** (B) bones form the great portion of the roof, and meet the **occipital** behind, which completes the roof, and is continued onwards to form a large part of the floor or base of the cranial cavity. The part of the occipital forming the floor is pierced by a large opening called the **foramen magnum**, through which the spinal cord passes to reach the brain. In Fig. 13 O is pointing to the extreme side limit of the occipital bone. The sides of the cavity are closed in by the **temporal bones** (D), one on each side. These contain the organ of hearing. In the figure D′ indicates a downward projection of the temporal bone, which is situated just behind the ear. It is called the **mastoid process**. The gap in the floor of the cranial cavity left by the occipital is filled up by the **sphenoid**, which thus stretches between the occipital behind it and the plates of the frontal occupying the roof of the eye-sockets in front of it. Part of the wing of the sphenoid is seen in the figures, and is marked C; but the main portion is at the base of the skull, and within, and is therefore not seen in the figures. The **ethmoid** is a very spongy bone, is not visible from the outside, and fills up the interval between the orbits. It forms the roof of the cavity of the nose, and is pierced by small openings for the passage of the nerves of smell. Fig. 13, *e*, shows the side of the ethmoid forming part of the inner wall of the orbit; the other side of the bone is in a similar position on the inner wall of the other orbit.

The fourteen bones of the face are—two upper jaw-bones (**superior maxillary**), two **malar** or cheek bones, two **nasal**, two **palate**, two **lacrymal**, two **inferior turbinated** bones in the nasal cavity, the **vomer** or ploughshare, and the lower jaw-bone (**inferior maxillary**). The **upper jaw-bones** (F) carry all the upper teeth, and form part of the floor of the orbit, the rest of which is completed by the **cheek-bones** (E), which also send an arch backwards to join the temporal bone. These arches (**zygomatic arches** *r*, Fig. 13) are the prominent ridges which run out from below the outer angle of the eye to the front of the ear. The **nasal bones** (G) form the bridge of the nose, and at their upper end they come into contact with the **lacrymals** (H, Fig. 13), placed in the inner angle of the orbit, and grooved for a duct, along which the tears pass from the eye to the nose. The cavity of the nose is divided into two by the **vomer** (J, Fig. 12), so called from its resemblance to a ploughshare, which forms a middle wall of partition between the two nostrils, while the **inferior turbinated** are scroll-like bones which project from the wall in the inside of the cavities (M and L, Fig. 12). The **palate bones** are behind those of the upper jaw, and with them form the bony part of the roof of the mouth. The **lower jaw-bone** (K) is the largest of the face bones, and carries all the lower teeth. It is the only bone in the head which is movable, a hinge joint being formed between its strong prominences, projecting upwards (*p*, Fig. 13), and a hollow in the temporal bone under the ends of the zygomatic arch. All the other bones of the head are immovably connected with one another, one bone presenting a ragged edge, like badly-formed teeth of a saw, the teeth fitting into corresponding notches in the edge of the other bone. These irregular lines of union are called **sutures**.

THE TRUNK.

This portion of the skeleton consists of the backbone or **vertebral column**, on the top of which the head is supported, and the chest or **thorax**.

The **Vertebral Column** is composed originally of 32 separate pieces, each piece being called a **vertebra**. In the adult state the separate pieces number only 26, several having become fused together. The separate pieces are arranged one on the top of the other, cushions of gristle being interposed between each (Fig. 14, *g*, *g*), which also help to unite them, while the union is completed by partially movable joints and by strong fibrous bands called ligaments. The column so arranged presents two forward curves, the first (*a*) in the neck, the second (*b*) at the lower part of the back, and there are two corresponding backward curves. The first seven vertebræ (1 to 7) occupy the region of the neck, and are, therefore, called **cervical** (Latin, *cervix* = the neck); twelve (from 7 to 19) are the supports from which spring the ribs, and constitute the main portion of the back, being called accordingly **dorsal**; the next five (19 to 24) are called **lumbar**, in the region called the "small of the back." Following these there come five bones, separate in early life, but united in the adult into one piece, called the **sacrum** (*s*), which forms with the haunch bones on each side a large basin-shaped cavity—the **pelvis**. Attached to the end of the sacrum is a small pointed bony mass, containing four vertebræ, originally separate and of a rudimentary kind, which corresponds with the bony part of the tail in other animals, and is called **coccyx** (*c*).

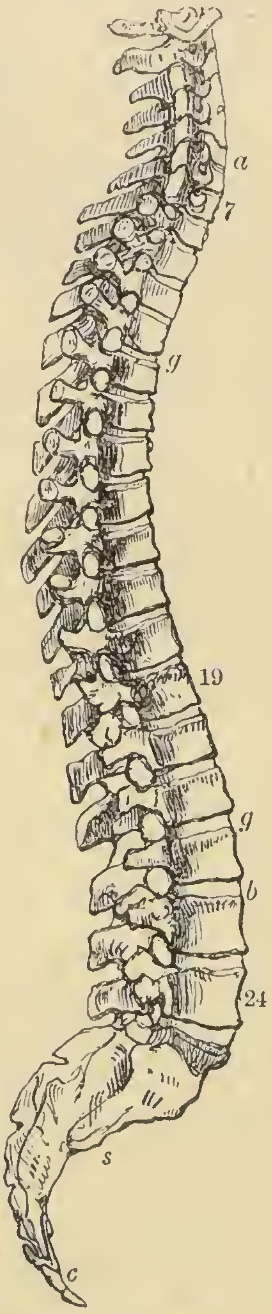


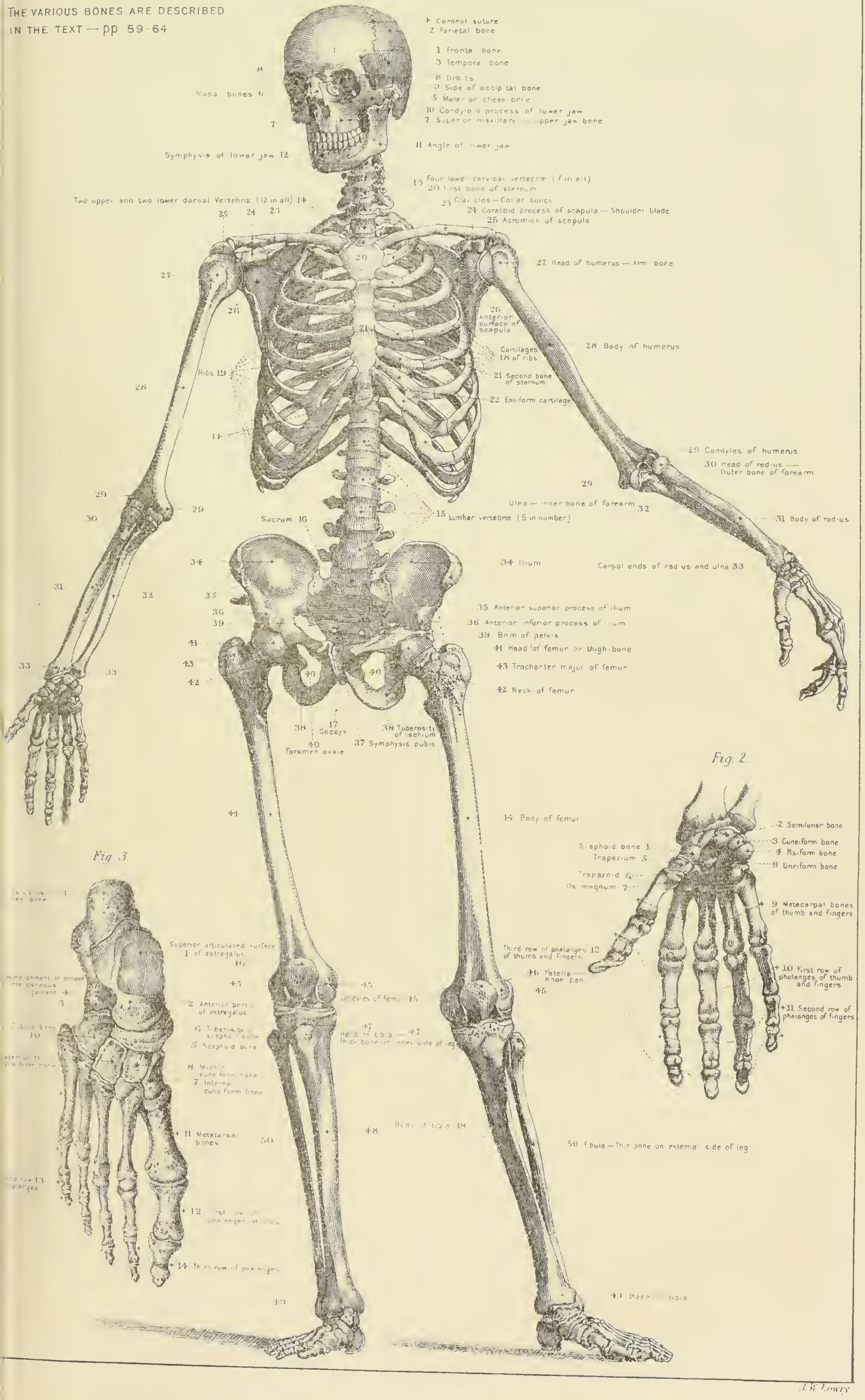
Fig. 14.—The Vertebral Column.

Each vertebra consists of a *body* (Fig. 15, *a*) from which two *arches* pass backwards (*c*, *c*), which meet in the middle line (*b*) and are prolonged into a projection or **process**—the *spinous process* (*d*). The arches inclose a *ring* (*h*). Projecting upwards and downwards from the sides of the ring are processes—two above by which the vertebra is united to the one above it, and two below for union with the one below it. These are called *articulating processes* (*g*, Fig. 15). Just about the position of these, there pass transversely outwards other two projections, one on each side, called the *transverse processes* (*e*). Now when the vertebræ

THE HUMAN SKELETON.

Plate IX

THE VARIOUS BONES ARE DESCRIBED
IN THE TEXT — pp 59-64


4 Coronal suture
2 Parietal bone
1 Frontal bone
3 Temporal bone
8 Orbits
9 Side of occipital bone
5 Malar or cheek bone
10 Condyloid process of lower jaw
7 Superior maxillary — upper jaw bone
11 Angle of lower jaw
8
Nasal bones 6
7
Symphysis of lower jaw 12
13 Four lower cervical vertebræ (7 in all)
20 First bone of sternum
23 Clavicles — Collar bones
24 Coracoid process of scapula — Shoulder blade
25 Acromion of scapula
Two upper and two lower dorsal Vertebræ (12 in all) 14
25
24
23
27
20
27 Head of humerus — Arm bone
26
26 Anterior surface of scapula
21
Cartilages 18 of ribs
28 Body of humerus
Ribs 19
21 Second bone of sternum
22
22 Ensiform cartilage
28
14
29 Condyles of humerus
30 Head of radius — Outer bone of forearm
29
29
30
29
Ulna — Inner bone of forearm 32
15 Lumbar vertebræ (5 in number)
Sacrum 16
31 Body of radius
34
34 Ilium
Carpal ends of radius and ulna 33
31
32
35
35 Anterior superior process of ilium
36
36 Anterior inferior process of ilium
39
39 Brim of pelvis
44
41 Head of femur or thigh-bone
43
43 Trochanter major of femur
33
33
42
40
40
42 Neck of femur
38
17 Coccyx
38 Tuberosity of ischium
40 Foramen ovale
37 Symphysis pubis
44
44 Body of femur
45
Condyles of femur 45
46 Patella — Knee pan
45
47
Head of tibia — 47 Thick bone on inner side of leg
48
Body of tibia 48
50
50 Fibula — Thin bone on external side of leg
49
49 Base of tibia
Fig. 2.
2 Semilunar bone
3 Cuneiform bone
4 Pisiform bone
8 Unciform bone
Scaphoid bone 1
Trapezium 5
Trapezoid 6
Os magnum 7
9 Metacarpal bones of thumb and fingers
Third row of phalanges of thumb and fingers 12
10 First row of phalanges of thumb and fingers
11 Second row of phalanges of fingers
Fig. 3.
3
ee bone
Superior articulated surface
1 of astragalus
46
45
mencement of groove
le osseous
jament 4
3
2 Anterior portion of astragalus
Cuboid bone
10
6 Tuberosity of scaphoid bone
5 Scaphoid bone
ternal 9
eiform bone
8 Middle cuneiform bone
7 Internal cuneiform bone
11 Metatarsal bones
50
ond row 13
alanges
12 First row of phalanges of toes
14 Third row of phalanges

J. W. Lowry

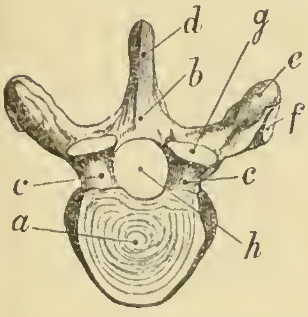


Fig. 15.—A Dorsal Vertebra.

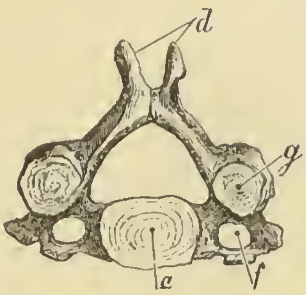


Fig. 16.—A Cervical Vertebra.

are in position the spinous processes are in line. They project backwards — the bodies being in front (see Fig. 14)—and give the irregular feeling that is experienced when one passes the hand down the centre of a person's back. At the same time the rings are all one above the other, and so form a canal (*the spinal canal*) in which the spinal cord lies, and by the bony walls of which it is protected. The vertebræ differ slightly according as they belong to the cervical, dorsal, or lumbar region. The cervical vertebræ (Fig. 16) have a canal (*f*) in the transverse process for the passage of an artery, and their spinous processes (*d*) are split at the extremity. The bodies of the lumbar vertebræ are more massive than those of the dorsal. Their transverse and articulating processes are more marked (see Fig. 17, references the same as in Fig. 15), and their spinous processes are hatchet-shaped and point straight backwards, while the spinous processes of the dorsal vertebræ overlap one another, and the transverse processes have little polished surfaces for uniting with the ribs (Fig. 15, *f*). The bodies of the vertebræ are of a different shape in the three kinds, as may be seen from the figures. The two uppermost vertebræ are peculiar. The first is called the **atlas** (Fig. 18) because it bears the head. It has very large surfaces (*g*) for a joint between it and processes of the occipital bone, and it is owing to this joint that the nodding movement of the head is possible. This vertebra has no body, but, instead, a small ring, separated from the large one (*l*) by a strong fibrous band which passes across between the two (see arrow lines in Fig. 18, *k*). The second vertebra is called the **axis** (Fig. 19), because its union with the first is such as to permit a turning movement between them, by which the head is turned to one side or another. This is effected by means of a process called the **odontoid** or tooth-like process, Fig. 19, *c*, *b*, *e*, which springs upwards from the body of the axis and fits into the smaller of the two rings of the atlas. The odontoid process is retained in this position by means of a joint between the surface *e* (Fig. 18) of the axis and the surface *d* (Fig. 19) of the process, as well as by strong fibrous bands, which also prevent it turning too far, and particularly by the ligament already mentioned as passing across between the two rings of the atlas. This ligament, in the living state, intervenes between the process in front of it and the spinal marrow behind it, and if it were to break, the process would crush backwards, destroy the spinal cord at this point, and so cause instant death. This occurs when the neck is broken.

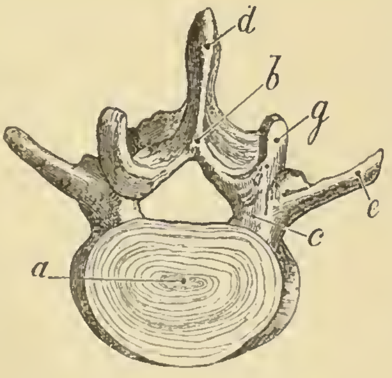


Fig. 17.—A Lumbar Vertebra.

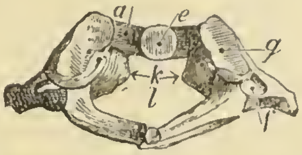


Fig. 18.—The Atlas Vertebra.[1]

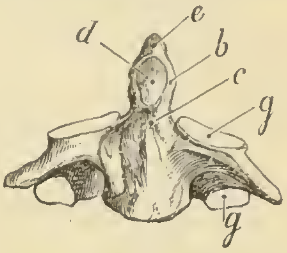


Fig. 19.—The Axis Vertebra.

The **Chest or Thorax** consists of the twelve dorsal vertebræ behind, of twenty - four ribs, twelve on each side, which spring from the vertebræ behind and arch forwards, and of the breast-bone or **sternum** (*o*, *p*, *q*, Fig. 20), to which, by means of cartilages, most of the ribs are united in front. All the twelve ribs on each side (1 to 12 in figure) are not connected with

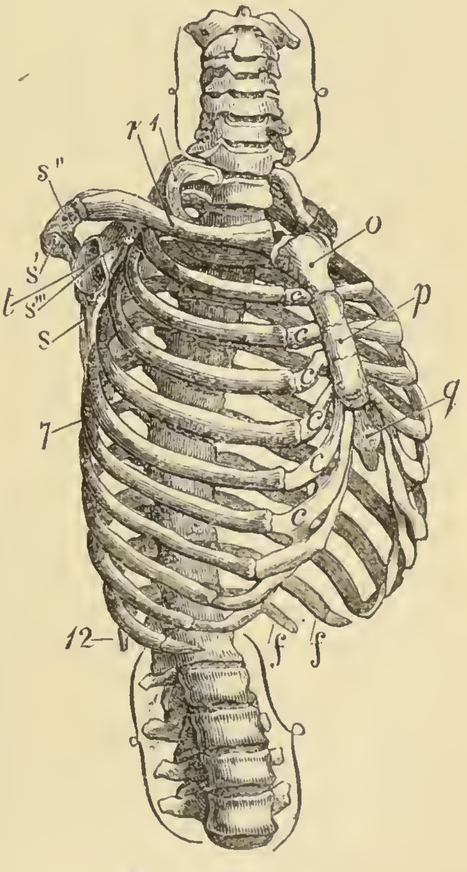


Fig. 20.—The Thorax.

The upper vertebræ inclosed in brackets are cervical, the lower lumbar.

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[1] The position of this figure is different from that of the others. It is the back part that is nearest the person looking at it. In the other figures it is the body or front part that is nearest.

the breast-bone. The first seven have each a separate piece of gristle (cartilage—*c*, *c*) uniting them, and are therefore called **"true ribs;"** the three next in succession are united by the same piece of cartilage, while the last two are quite unconnected with the sternum, and terminate in the muscular wall of the belly. The last five are termed **"false ribs,"** the last two (*f*, *f*) being also called **"floating ribs."**

The attachment of the ribs to the vertebræ is effected by joints which allow of considerable movement, so that the ribs can be elevated or depressed, and thus the cavity which they inclose may be increased or diminished in size. The cartilages confer elasticity on the bony walls of the chest; but in advanced life much of this elasticity is lost by the cartilage becoming brittle owing to a deposit of lime in them, and consequently the chest becomes less capable of movement.

THE UPPER EXTREMITY.

The arm is connected with the chest or thorax by means of two bones which together receive the name of the shoulder girdle. They are the collar-bone or **clavicle** (*r*, Fig. 20), and the shoulder-blade or **scapula** (*s*, Fig. 20). The **collar-bone** stretches from the top of the breast-bone (*o*, *p*, *q*) outwards, and forms the prominent point of the shoulder. The **scapula** lies on the back of the thorax, where it is freely movable, and is attached to the outer end of the clavicle by strong fibrous bands. It has a strongly developed spine (*s*′) for the attachment of muscles, and two processes (*coracoid s*‴ and *acromion s*″, the latter a prolongation of the spine) by which its attachment to the clavicle is effected. At one of its angles it has a polished hollow (the glenoid cavity—*t*) lined with cartilage, into which the head of the arm-bone or **humerus** (Fig. 21) fits, thus forming the shoulder joint. The lower end of the humerus is broadened out by a projection on both the outer and inner sides, the outer and inner **condyles**, and has a pulley-like surface (*b*) for articulating with the forearm to form the elbow joint. The **forearm** consists of two bones, **ulna** and **radius**. The **ulna** (Fig. 22, 1) is the inner of the two, is large at the upper end, where it has two projections, one, *the coronoid* process (*b*), in front, and the other, the *olecranon* process (*a*), behind. Between these two is a deep groove (*c*) into which the smooth pulley-like surface of the humerus is received, forming a hinge joint. The olecranon behind forms the sharp prominence of the elbow. The lower end of the ulna is slender. The **radius** (Fig. 22, 2) is the outer of the two bones, is small at the upper end, where it is connected with the ulna, so as to permit its head to have a rotary movement, and is large and expanded at the lower end (*g*), where it forms part of the wrist joint. The arrangement of these joints is such that the radius can roll, as it were, half-way over the ulna. It carries the hand with it, which is thus turned palm downwards—in the act of what is called **pronation**; when the radius is rolled back again the hand is turned palm upwards, that is, the back of the hand is now downwards—**supination.**

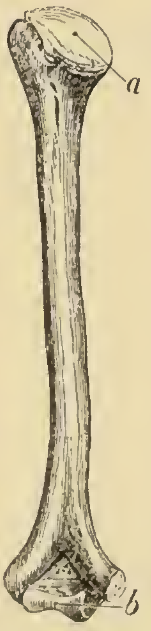


Fig. 21.—The Humerus.

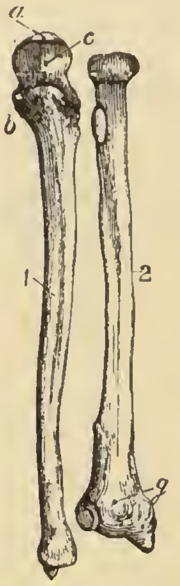


Fig. 22.—The Ulna and Radius.

The bones are shown displaced from one another in the figure. The radius (2) is above its proper position. Its head should move on the side of the ulna below the level of the hollow (c).

The **wrist or carpus** (Fig. 23) is made up of two rows of small bones, four in each row. Beginning from the thumb side these bones are named as follows: **Scaphoid** (1), **Semi-lunar** (2), **Cuneiform** (3), and **Pisiform** (4), in the first row; **Trapezium** (5), **Trapezoid** (6), **Os Magnum** (7), and **Unciform** (8), in the second row. These small bones are allowed a slight amount of movement on one another by means of joints. The **palm** of the hand contains five shafted bones called **metacarpal bones** (*m*), which means coming after the carpus or wrist. These metacarpal bones support the **phalanges** (*p*) or bones of the finger. There are three phalanges in each finger, diminishing in size towards the point. The thumb has only two phalanges (Fig. 23, *p*′).

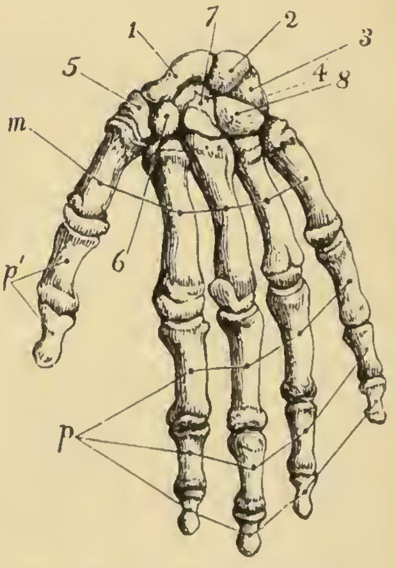


Fig. 23.—The Hand, from behind.

A dotted line leading to 4 shows the position of the pisiform bone, which rests on the cuneiform, and can be seen only from the front.

THE LOWER EXTREMITY.

Like the upper extremity, the lower is connected to the trunk by means of a girdle called the **pelvis or pelvic girdle** (Fig. 24). The pelvis is formed, behind by the prolongation of the vertebral column, **os sacrum** and **coccyx**, and at the sides by two large irregularly-shaped bones, which curve forwards from the sides of the sacrum. The name given to each of these bones is **innominate bone** or the unnamed bone. In the figure the lines *I* on each side of the back-bone indicate the place of union with the sacrum. The innominate bones meet in front at the **symphysis pubis** (*sp*), a pad of gristle intervening. Each **innominate** bone consists in early life of three pieces, termed **Ilium** (A), **Ischium** (B), and **Pubis** (C). When the pelvis is looked at as a whole, a prominent ring can be followed from the sacrum behind round to the symphysis in front; this is called the **brim of the pelvis**. The inclosed cavity contains the urinary and generative organs and the lower part of the bowel. In the erect position the pelvis forms an angle of 60° with the horizontal, so that the pressure communicated by the back-bone is thrown, by this inclination, on to the innominate bones. Strong fibrous bands, passing from the sacrum to the part of the innominate bone called the ischium (at the point where the B is placed in the figure), prevent the sacrum from being forced forwards by the pressure. In the pubic portion of the bones is an irregular opening—obturator foramen—(O) through which blood-vessels, nerves, &c., pass outwards. In the innominate bone of each side is a large and deep irregularly formed cavity (*a*), which is lined with gristle and receives the head of the thigh-bone. It forms a very deep socket; and the thigh-bone has a correspondingly large globular head. This large socket is called the **acetabulum**.

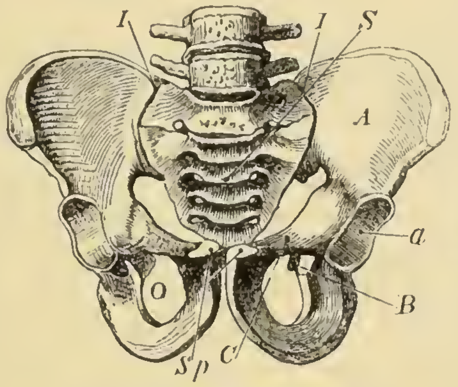


Fig. 24.—The Pelvic Bones.

The **thigh-bone or femur** (Fig. 25) is a very large and strong bone, and presents a shaft (A) with a rough ridge on the back for the attachment of muscles. At its upper extremity, besides the globular head (1) already mentioned, it has two rough prominences, one large and external (2), the other small and internal (3). These are called the **large and small trochanters**. The former can be felt just beneath the skin on the outer side of the hip-joint. The lower end of the femur is broad and irregularly shaped, and has two enlargements, one to the inner, the other to the outer side, called **condyles**, and fitted for forming a hinge joint with the succeeding bone of the leg. The leg has two bones, the inner called **Tibia** or shin-bone (Fig. 25, 1), the outer called **Fibula** or clasp bone (2). The tibia is much the larger of the two, and above is connected with the thigh-bone (at *b*) to form the knee joint, the fibula being attached to the outer side of its head. In front of the knee joint, situated within a tendon, is the knee-cap or **patella** (shown in Fig. 25, 3, but out of position).

The lower end of the tibia and of the fibula enter into the ankle joint, the weight being conducted to the foot by the tibia. The lower end of the tibia projects on the inside of the joint, and the lower end of the fibula has a similar prominent process on the outside of the joint. These processes are termed **Malleoli**.

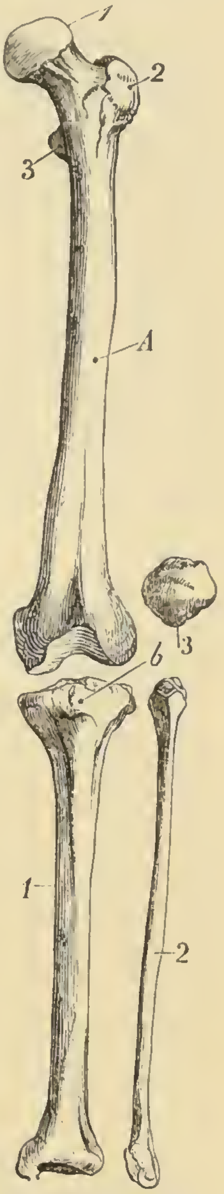


Fig 25.—The Bones of the Leg, left side.

The **Foot** (Fig. 26) consists of three parts, like the hand, **Tarsus**, **Metatarsus**, and **Phalanges**. The **tarsus** consists of seven bones, viz.: **os calcis** or heel-bone (1), the **astragalus** or ankle-bone (2), resting above the os calcis and supporting the tibia, the **cuboid** (3), in front of the os calcis, the **scaphoid** (4), in front of the astragalus, and in front of the scaphoid

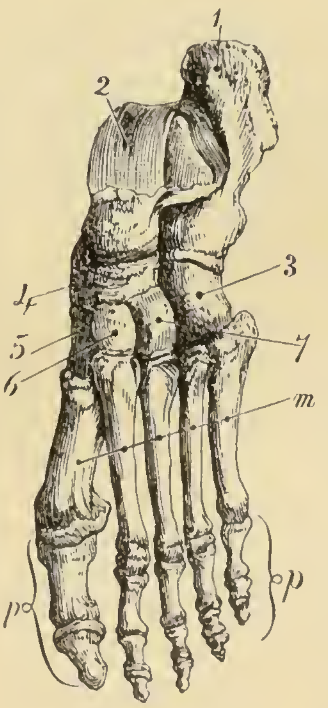


Fig. 26.—The Foot.

are the **internal** (5), **middle** (6), and **external** (7), **cuneiform**. Like the five metacarpal bones forming the palm of the hand, succeeding the tarsus are five **metatarsal** bones forming the sole of the foot (*m*). To these succeed the bones of the toes, each toe having three **phalanges** (*p*), except the great toe, which has only two. Here the resemblance to the fingers and thumb is apparent.

Fig. 27 shows the position of the tibia astride of the astragalus, and the great projection behind of the os calcis (c), to which is attached the tendon of the calf muscle. This figure also shows the peculiar arch of the foot, of which the os calcis and the balls of the toes are the piers. It is easily seen how well this arrangement is adapted for supporting the weight of the body.

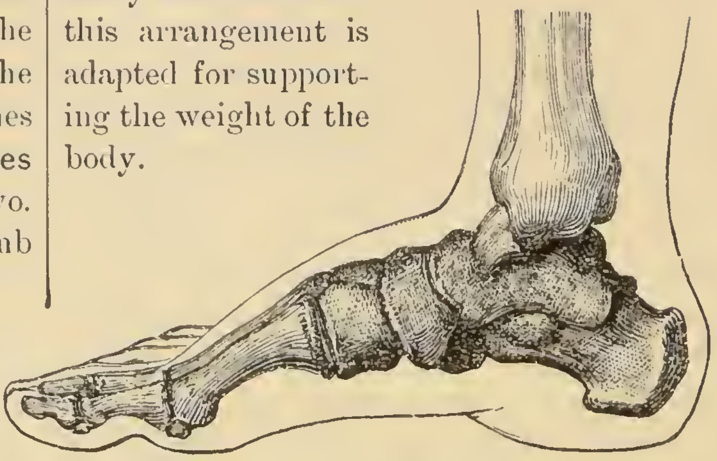


Fig. 27.—The Foot, from the side.

THE JOINTS.

By **Joint** or **Articulation** is meant the union of two bones by means of other structures. The structures that enter into the formation of a joint are: (1) **bone**, (2) **cartilage** or gristle, (3) **synovia**, a smooth delicate membrane which lines all parts of the inside of the joint except the opposing surfaces of cartilage, (4) **ligaments**, strong bands to bind the bones together.

Bone has already been described (p. 57).

CARTILAGE.

Hyaline cartilage consists of a ground substance of a fine ground-glass appearance, containing cells, which have a nucleus and nucleolus, and lie in spaces in the ground substance inclosed by a capsule. One cell may fill one space, but oftener two, three, four, or more cells are present, which have obviously originated by division from one original cell (Fig. 28).

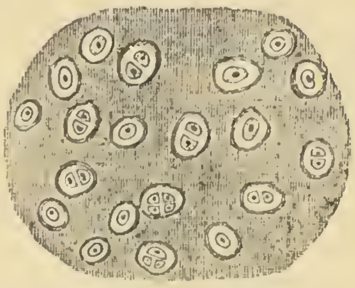


Fig. 28.—Hyaline Cartilage, as seen magnified.

In **white fibro-cartilage** the ground-substance is everywhere pervaded, and almost replaced, by white fibrous tissue, disposed in layers of bundles, the encapsuled cartilage cells lying between the bundles.

In **yellow fibro-cartilage** yellow elastic fibres form a basket-work, the cartilage cells occupying the meshes.

The first variety is found coating the opposing ends of bones, entering into the formation of a **joint (articular cartilage)**, forming the portions of the ribs that become attached to the breastbone (**costal cartilage**), and it is this kind of cartilage that occupies the place of bone in fœtal life, being afterwards replaced by bone. White fibro-cartilage is found in the discs between the vertebræ of the spinal column; and the third variety forms the main portion of the lid of the windpipe—the epiglottis, and of other cartilages of the voice-box or larynx (p. 354).

Cartilage is tough but highly elastic. Disposed between bones it acts as a buffer, while permitting a certain amount of flexibility.

THE SYNOVIAL MEMBRANE.

This is a very delicate tissue, and from it a fluid, synovia, is poured out to moisten the cavity of the joint and so reduce the amount of friction and heat developed by movement. It is formed of a single layer of cells resting on a connective-tissue basis, and is richly supplied with blood-vessels.

LIGAMENTS.

These are connecting bands made of bundles of delicate wavy fibres bound firmly together. They are not elastic. They pass from one bone to another, strongly supporting the joint, which sometimes they completely surround.

VARIETIES OF JOINTS.

In a joint, then, you have the ends of two opposed bones, of which the opposing surfaces are coated with cartilage; strong ligaments pass between them to complete and maintain the union; and the inner surface of the joint cavity is lined by a membrane which pours out a fluid to lubricate the joint.

It is, however, only **perfect joints** that are thus fully equipped, and there are joints which want one or other or several of these structures, which are therefore called **incomplete or imperfect joints.**

Imperfect Joints. The bones of the skull are united by their ragged or serrated edges being dovetailed into one another, no structures intervening between the bones. Such joints are called **sutures** and are immovable.

In the union effected between the bodies of the vertebræ there is an example of incomplete joints, which are *partially* movable. Between two opposed bodies of vertebræ there is a pad or cushion of cartilage of the white fibrous kind. The pads are elastic and useful in preventing jars to the vertebral column. Besides, they allow of a considerable amount of movement over all, though very little between any two vertebræ. The union is strengthened by ligaments, but there is no synovial membrane.

Perfect Joints. There are various forms, according to the nature and amount of the movement permitted.

Ball-and-socket Joints. In this form one bone has a cup-like depression into which the head of the other fits. This is the kind of joint existing between the head of the arm-bone and the glenoid cavity (p. 62) of the shoulder-blade, and between the head of the thigh-bone and the acetabulum of the innominate bone. In the hip-joint the head of the bone is kept close in the cavity by means of a special ligament within the cavity itself, the **round ligament**, which passes from a depression in the bottom of the acetabulum to the head of the thigh-bone. Ball-and-socket joints permit free motion in almost any direction.

Hinge Joints. Here the opposing surfaces of the bones have elevations and depressions which fit into one another and allow of movement only in one direction. The elbow, ankle, and knee joints are examples of this kind.

Pivot Joints. The best example of this is the joint between the first and second vertebræ, the pivot being formed by the odontoid process of the axis, and the ring in which it is placed being provided by the atlas vertebra. The kind of movement permitted here is rotary.

Shifting Joints. In this last kind the amount of movement is restricted and amounts to only a slight gliding between the ends of the bones. The joints between the bones of the wrist and those between the bones of the ankle are good examples.

Besides the ligaments and muscles, a force tending to keep bones in joint is the pressure of the outside air. The hip-joint, for example, is so completely surrounded by ligaments as to be air-tight; and the union is a very strong one. If the ligaments be pierced and air allowed to enter the joint, the union becomes at once much less close and the head of the femur falls away as far as the ligaments will allow it.

MOVEMENTS OF JOINTS.

Joints allow of various kinds of movements, the chief of which are:—

Angular movement, as when the bones so move as to form an angle between them in the same line or plane. Angular movements include those of **flexion** and **extension**, as when we bend or straighten the forearm on the arm at the elbow; **adduction**, as when the arm is brought to the side from the extended position; and **abduction**, when it is carried from the side towards the extended position.

Coaptation is the term applied when one surface glides over the other like a wheel rolling on the ground, so as to bring successive surfaces into contact. This is seen in the movement of the knee-pan on the lower end of the femur.

Circumduction occurs when the shaft of a long bone describes a cone, the point of which is in the joint, while the base and sides of the cone are described by the moving part, as exemplified by the swinging of the arm when we attempt to make a circle in the air on one side of the body. The same movement can be described by the leg, the joint involved being the ball-and-socket joint of the hip.

Rotation. In this case the bone moves round an axis, as seen in the movements of the *atlas* on the *axis*. (See p. 61.)

SECTION III.

THE BONES AND JOINTS.

THEIR DISEASES AND INJURIES.

Diseases of Bone:

Inflammation (1) of Bone itself (*Ostitis*), and how it may end in Death of the bone (*Necrosis*), Suppuration (*Abscess*), or Ulceration (*Caries*); (2) of Periosteum (*Periostitis*); (3) of Endosteum (*Osteomyelitis*).

Spinal Curvature—Posterior and Lateral.

Rickets.

Softening of Bone.

Tumours of Bone.

Diseases of Joints:

Inflammation of Joints—Synovitis—Dropsy—White Swelling—Chronic Rheumatic Inflammation—Rheumatoid Arthritis—Hip-joint Disease—Housemaid's Knee.

Hysterical Affections of Joints.

Injuries of Bone:

Fracture: General Considerations—Causes, Kinds, Mode of Union, Non-union, Signs, Treatment.

Special Fractures of Skull, of Bones of the Face, of Lower Jaw, of Collar-bone, of Shoulder-blade, of Upper Arm, of Forearm, of Wrist, of Palm of Hand, of Fingers, of Spine, of Ribs and Breast-bone, of Pelvis, of Thigh, of Knee-pan, of Leg, of Bones of the Foot.

Injuries of Joints:

Dislocation: General Considerations—Causes, Kinds, Results, Signs, Treatment.

Special Dislocations of Spine, of Lower Jaw, of Collar-bone, of Shoulder-blade, at Shoulder, Elbow, and Wrist Joints, of Thumb and Fingers, at Knee and Ankle Joints, and of Bones of the Foot.

Sprains. See page 123.

DISEASES OF BONE.

INFLAMMATION OF BONE.

It has been seen that bone has blood-vessels passing through its substance in great numbers, and that it is coated without and within by membranes—periosteum and endosteum—which also are richly supplied with vessels. Bone is, therefore, liable to the changes that occur in inflammation. It is also easily understood that the disease may attack (1) the substance of the bone itself, or (2) the periosteum, or (3) the endosteum and the cavity containing the marrow, which it lines. In the first case the inflammation is called **ostitis**, in the second **periostitis**, in the third **osteomyelitis**.

Inflammation of Bone itself (*Ostitis*). **Course.**—(1) Increased quantity of blood and the enlargement of the blood spaces, which are the earlier occurrences of inflammation, cause the bone first of all to become less dense, more porous, and therefore lighter, softer, and more fragile. (2) But succeeding this is a stage of thickening, when material which has passed through the walls of the inflamed blood-vessels becomes organized to form new tissue. In this tissue bone salts become deposited, and thus quantities of new bone are formed which fill up the spaces of the healthy bone and render it more hard, and dense, and thick. Should the disease not be arrested at this point other consequences may follow. (3) The continued inflammation may cause suppuration and the formation of an abscess. The matter may be collected at one place in the bone; but, in cases of persons of very bad constitution, the matter may extend all through the bone. (4) Ulceration may occur, in which the bone breaks down or may be said to melt down into unhealthy matter, which works its way to the surface and bursts. It may burst into a joint. As the ulceration continues there is a constant discharge through the opening that has been formed. This ulceration in bone is called **caries**. It is not likely to result from inflammation of bone in persons of good habit of body, but is liable to occur in persons, and specially young persons, whose constitution is tainted with scrofula. It occurs oftenest in the spongy part of the bone, and particularly in the heads of the long bones, and in short bones like those of the wrist, or foot, or the vertebræ. (5) The bone may die, not in minute particles, as in caries, but in pieces, either in a thin slice from the surface or a complete portion of the whole thickness of the shaft may die. This mode of termination of inflammation is called **necrosis**, and the dead piece is called a **sequestrum**. When part of the shaft of a long bone has died in this way it is not uncommon for the periosteum (from which, as already mentioned, the growth in the circumference of the bone proceeds) to produce a layer of new bone, so that the dead portion becomes encased within a shell of new material.

This disease may be acute or chronic. It is in the chronic cases that very great thickening, caries, or necrosis will result. It often extends over years with intervals of rest between attacks. It occurs oftenest in the young, and in the bones of the head and of the thigh or leg (femur or tibia). It is usually attributed to cold, but the chronic forms may be due to constitutional disease like scrofula or tubercle or syphilis.

Symptoms.—The first sign is violent, deep-seated pain, worse at night. There is high fever, ushered in by shivering. In a few days there is swelling of the leg in the neighbourhood of the diseased bone, the skin becoming red and boggy to the feeling. The health suffers rapidly and severely, the patient often sinking under the violence of the attack. If an abscess forms in the bone there is often severe fixed pain at one particular spot which nothing relieves. When caries or necrosis has occurred there will generally be one or more openings through the soft parts which refuse to close. In *necrosis* this open channel, **sinus**, as it is called, will lead down to the dead bone, and a probe being passed in the right direction will touch it and give a rough, grating, and metallic feeling, sometimes the piece being felt to be loose in the cavity. In *caries*, thin, ill-smelling matter will issue from the opening, the edges of which are red and pouting, and a probe gives the sensation of softness and grittiness, the bone breaking down under the touch.

Treatment.—This is a disease that may be extremely severe, and may kill with great rapidity, and therefore, wherever possible, qualified medical aid should be obtained.

For acute inflammation the limb must be kept absolutely at rest, the person being in bed. Warm cloths should be employed, and several leeches applied over the inflamed portion. Opening medicines, such as salts, seidlitz, &c., should be given, and the person kept on low diet, no rich stimulating foods or large quantities.

If, however, the disease is chronic, especially when due to scrofula, that is to say, is tubercular, the patient requires strengthening food and tonic medicines—good food, with change of air, sea-air being best, cod-liver oil, and teaspoonful doses of syrup iodide of iron repeated twice or thrice daily. The part affected may be blistered or painted over with iodine. The agonizing and continuous pain over a special spot due to an abscess in the bone can only be relieved by an operation by which the bone is cut into and the matter allowed to escape. This, of course, only a surgeon can do.

When caries or necrosis has resulted, the strengthening and tonic treatment is specially necessary. The discharge is nature's method of removing the diseased portions of bone, but it is a tedious method under which the sufferer may sink. It is, therefore, often advisable, and sometimes necessary, that the diseased portions should be removed by a surgical operation.

Inflammation of the Periosteum (*Periostitis*).—It has been noted how richly this outer fibrous coating of the bone is supplied with blood, and also how growth of the bone in its thickness is due to it. It can, therefore, be seen how seriously the bone may be affected by diseased conditions of the periosteum.

The **course** of the disease is similar to that of inflammation of the bone proper. (1) Owing to the great increase of blood, growth will be excessive, and there will be considerable new formation of bone beneath the inflamed membrane. The thickening may, should the inflammation pass off, gradually diminish and become absorbed. The thickening may be so great as to amount to an actual bony tumour projecting outwards to a greater or less extent. In this case it is called an **exostosis**. The thickening of the bone will of course be of limited extent, and the result may be to produce distinct elevations or **nodes** of the bone, easily felt, and sometimes seen through the skin. (2) The disease may go on to suppuration. This may be very serious, for the matter will collect underneath the periosteum, between it and the bone, separating the one from the other. Should the separation continue for any time, the matter not being allowed to escape, and the membrane not allowed again to become applied to the bone, then the surface portion of the bone from which the separation has been made, being deprived of its nourishment, will die and (3) necrosis results. Instead of necrosis, however, there may be (4) ulceration of the surface of the bone—caries—determined by the bad constitution of the person. Periostitis occurring near a joint may extend into it.

The disease may be acute or chronic.

The **causes** of the acute form are cold and injury. Acute periostitis is often caused in school-girls by a wetting, the wet clothes knocking against the legs and so exciting the disease. The chronic form is due to constitutional diseases like scrofula, syphilis, rheumatism, or gout. The scrofulous form attacks children specially, the parts oftenest affected being the sparely-covered bones, for example, those of the head, the collar-bone, and those of the leg (tibia) and arm (ulna). Syphilis is the most frequent cause of the chronic forms, and specially leads to the formation of limited thickenings and nodes.

Excessive use of mercury is also a powerful agent in the production of this kind of inflammation.

Symptoms.—There is fever, quick pulse, loss of appetite, &c. The person complains of intense pain in the affected part, which is increased by pressing on the place and is aggravated at night. Care should be taken not to attribute this in children to growing pains, or in older people to rheumatism. After a little time the part becomes swollen, and the skin over it red and glazed, which again is liable to be confounded with erysipelas (Rose, St. Anthony's fire).

Treatment.—A. *For acute attack.* (1) Rest in bed, the affected limb being *raised* on pillows. (2) Low diet—milk, &c. (3) Saline purgative medicines—salts, seidlitz, &c. (4) Put several leeches over the affected part, and after they come off use warm fomentations. After the acute attack has passed off the patient may be very low and exhausted, when nourishing food and tonic medicines (such as tincture of Peruvian (cinchona) bark, half a tea-spoonful several times daily to a child), and sometimes wine are needed.

B. *For chronic forms.* Paint the part with iodine, or use small blisters. If the disease be due to scrofula, cod-liver oil is necessary, or chemical food; if to syphilis, it must be treated as for syphilis. For both syphilitic and rheumatic periostitis probably iodide of potassium will be best; and it may be given in five to ten grain doses in water twice or thrice daily (for an adult). If a collection of matter has formed, which deep-seated constant pain will indicate, the only remedy is an incision to let out the matter. This cannot be done by inexperienced persons.

Inflammation confined to Inner Lining Membrane (*Endostitis, Osteomyelitis, Medullitis*).—This is a rare affection, and when it does occur it is generally after amputations, or owing to bullets, &c., being lodged in the cavity of the bone.

SPINAL CURVATURE.

The bones of the backbone are, equally with other bones, liable to inflammation and its various consequences; but here the results are much more serious and much more marked. It is usually the bodies of the vertebræ, in front, that are attacked. They get softened and break down, in fact ulceration (caries) of the front of the bodies takes place. A large portion, therefore, of the body of one or several of the vertebræ gets scooped out, the intervening cushions of gristle suffering as well. The result of this will be obvious. The vertebral column transmits the weight of the body downwards. In consequence of this weight, therefore, the softened vertebræ will get crushed together in front, and bending of the backbone will result, a projection behind being formed. (Fig. 29.)

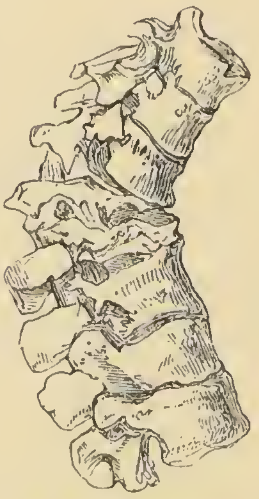


Fig. 29.—Disease of the Spine.

Angular or **Posterior Curvature** is the term applied when the projection is backward, or Pott's Curvature, after an English surgeon, who first described it as a separate disease; and a more technical name is **kyphosis**, when the curve is backward, and **lordosis** when the curve is forwards. When the vertebræ have thus become crushed together the disease may cease, and a cure be effected by union taking place between the bones, though this may take two or three years. Not infrequently, however, this crushing together has a fatal effect. The spinal cord is inclosed within the spinal canal formed for its protection. When the curvature occurs the bending may produce pressure upon the cord, and death may be due to its being crushed. Death is, however, generally due to exhaustion.

The broken-down matter of the bones is often of very considerable amount. Like any other fluid it will seek the lowest level, and so will work its way through cellular tissue and between muscles until it is able to reach the skin, where it points in the form of an abscess. There are several special places where these abscesses make their appearance, places determined by the position of the disease, of which the chief are (1) low down in the back—lumbar region—forming **lumbar abscess**, and (2) at the upper portion, and in front, of the thigh, forming **psoas abscess**, from the name of the muscle over which it lies. The abscesses, instead of coming to the outside, may burst into the lungs, or into the spinal canal, or into the cavity of the belly, &c., and so cause death.

Signs.—The disease progresses slowly, and at its commencement the symptoms may be very vague. A peculiar awkwardness and stiffness of walk and carriage may first be noticed about the person. When he stoops to lift something from the ground the back is held stiff instead of curving round. There is loss of sprightliness and elasticity; and the person walks, moves, sits down, or rises up in a way to prevent jars. Jumping or a high step is avoided, great distress being often occasioned by a sudden slip. It often begins with symptoms due to pressure on the spinal cord, causing irritation, such as weakness, coldness and numbness of the legs, and perhaps twitchings, and even paralysis. The digestion is disturbed; the bowels are costive; and if the disease be high up among the dorsal vertebræ the breathing is difficult and distressed, sudden and shooting pains being complained of through the chest and abdomen. There are several ways of obtaining symptoms of the disease. If it is suspected in a young child it should be stripped and laid across the knees, face downwards. When the knees are slowly separated the spinal column is slightly lengthened out, pressure is taken off, and the child will give signs of relief. Then bring the knees together again, place one hand on the top of the head and one on the buttocks, and let the hands push against one another. The vertebræ are pressed together, and the child shows signs of pain. Tapping with the knuckle down the back, over the spinous processes, will often produce a sudden shrinking of the body from the touch when the place over the diseased part is struck. Similarly, when cold and hot sponges are passed alternately down the back, distinct shrinking occurs on passing the seat of disease. Children do not so much complain of the spinal tenderness, but with adults the tapping produces a sickening sensation. When the vertebræ of the neck are affected the head is held very stiffly, and not moved sideways, the person preferring to turn the whole body. There will be difficulty in supporting the head, which the patient steadies with his hands.

Finally, there is the appearance of a small knuckle of bone projecting somewhere in the line of the spinous processes, which goes on increasing.

Treatment.—The object of treatment is threefold: (1) to give rest to the spine, in the hope that the disease may begin to mend when the irritation, constantly occasioned by the slightest movement, is removed; (2) to give support to the spine, so that, by removing the weight from the diseased bones, the crushing-in process may proceed as little as possible; and (3) to support the strength and increase it as far as may be, since lowness of health is a feature of the disease, and death by exhaustion one of its not infrequent terminations. Now, formerly, the first two of these conditions were fulfilled by keeping the sufferer strictly confined to a bed or sofa, lying on the back. The objection to this is manifest; it impaired seriously the patient's vigour, and, if anything, aided the progress of the affection. Mechanical means of fulfilling the conditions naturally enough were resorted to, and various complicated kinds of apparatus have been invented and used for the purpose. These, however, were so cumbersome as to be irksome and borne with difficulty by those who could afford them at all, while they were quite beyond the reach of the poor owing to their cost. Some years ago, however, a method was devised by Professor Sayre of New York, which entirely fulfils the conditions, is not attended by the objections mentioned, and has produced in many cases marvellous results. Simply stated it consists in applying to the patient's body from the hips to the arm-pits a continuous bandage of plaster of Paris, which, when "set", ought to be quite hard and stiff, and so affords a perfectly adjusted and close-fitting support. Next the skin the patient has a tight-fitting knitted worsted jersey. The bandages are of wide-meshed material, into which the fine plaster of Paris is rubbed dry, and the bandage then rolled up into a regular roll. The bandages are placed, end up, in a basin of water, five or ten minutes before being required for use. In order to stretch the spinal column and take off from it all pressure, before the bandage is applied, the patient is suspended by the head and shoulders, so that the tips of the toes just touch the ground. The apparatus by which this is done consists of a tripod, which suspends a pulley (Fig. 30). Passing over the pulley is a cord,

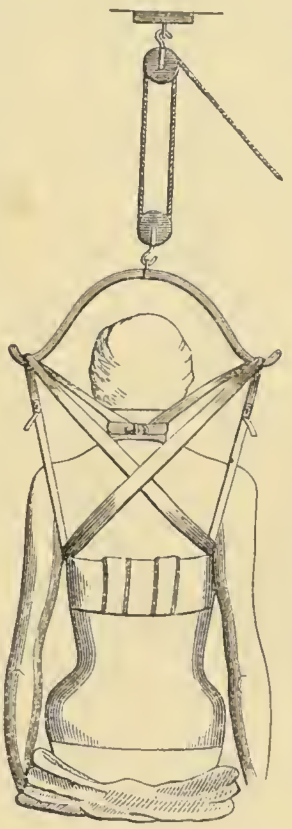


Fig. 30.—Suspension Apparatus for use in Spinal Disease.

one end of which has attached to it a cross-bar. From the bar there hang two well-padded slings, one of which is placed under the arm-pit of each side, and there is also a padded circular strap which supports the chin and back of the head (Fig. 31). When the slings and strap are adjusted the patient can be raised, or can even raise himself, by pulling on the other end. The same sort of apparatus could be employed without the tripod by means of a hook screwed into a roof or door-sill. On the patient, thus suspended, the bandage is applied on the top of the jersey. Beginning below just over the hips, the operator winds it regularly upwards, turn after turn, till the arm-pits are reached. To make it stiff enough several layers will be necessary, requiring perhaps 25 to 35 yards of bandage. After one layer is complete it is well to cover it with a cream-like paste made of the plaster of Paris and water, putting it on and smoothing it over with the hands. Another layer of bandage and another quantity of the paste are then used, and so on. Still further to strengthen the plaster, strips of perforated tin about the length and breadth of corset whale-bone or steel are introduced at the sides and back, and additional layers of the bandage over them. The tin is perforated because the rugged edges of the holes cause the strips to "grip" well. When sufficient of the bandage has been put on, the patient is carefully lifted down from the suspending apparatus, not being himself allowed to move the slightest degree, and, being kept quite straight, is laid down so on a hard mattress on the floor to allow the plaster to "set" thoroughly. This probably will be accomplished in half an hour. Then he may put on his clothes and go about. Very often the application of this bandage has enabled persons to walk who were previously quite helpless.

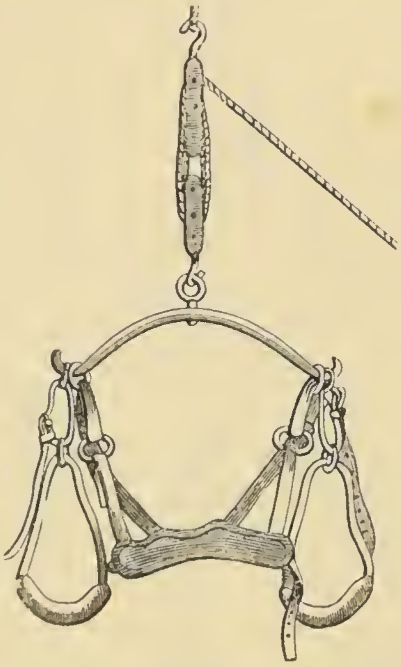


Fig. 31.—Slings, &c., of Suspension Apparatus.

When the disease is high up in the dorsal region, or in the cervical region, an additional arrangement is necessary for the support of the head. It consists of a light piece of iron fixed by the bandage to the back, and projecting upwards as high as the head. From the top of it a piece of iron arches directly *over the head*, and from this arch straps are suspended for supporting the head by the chin and occipital bone behind.

When the bandage is being put on, a pad ought to be placed over the stomach, to be removed after the plaster has "set" over it. It leaves room for the distension of the stomach with food. Even the presence of an abscess on the back need not interfere with this method of treatment. For, after the plaster has hardened, an opening or window can be cut in the jacket at a marked point exactly over an abscess, allowing of its being regularly dressed.

Besides this mechanical treatment there is the constitutional—good nourishment in plenty, fresh air, cod-liver oil, Parrish's chemical food, or other syrup of the phosphates of iron and lime, and other tonics.

Any abscesses that may appear in the course of the disease require to be opened, to let the matter escape, and treated in the ordinary way. (Refer to ABSCESS. See INDEX.)

The practice of making and keeping up issues, by the use of caustics, at the side of the backbone, is not now so frequently followed as formerly.

Lateral Curvature (*Scoliosis*).—This is not a disease, like the former one, attended with serious destruction of tissues. It is due to a relaxed state of the body, to greater development of muscles on one side than on the other, or to weakening of one side, which some special employment might give rise to; or it is due to the adoption of a peculiar attitude, such as "standing at ease" on the right leg with the left knee a little bent, or to an attitude assumed in writing or at needlework, specially if the person be short-sighted. Nurses who carry children always on the same arm are liable to it. It is sometimes the result of chest disease, pleurisy, or of one leg being shorter than the other. It attacks girls between the ages of ten and fifteen, particularly those who grow too fast for their strength.

Signs.—On uncovering the whole back the curve of the backbone is observed to follow the outline of the italic *f*; one shoulder is higher than another, and one shoulder-blade projects. The right shoulder is usually the high one, and the left is depressed. Similarly, while one hip, usually the left, projects, the other is curved inwards (Fig. 32). There may be other symptoms, due to the deformity causing oppression of breathing, or pressure on the nerves producing pains.

The **treatment** is not dissimilar to that of the former disease. Mechanical support by the plaster-of-Paris bandage may be used, the unnatural attitudes being, as far as possible, discarded. But special benefit will be derived from strengthening food, from the use of medicines already advised for posterior curvature, and from the patient being caused to take regular exercise, and to have a moderate course of gymnastic exercise. If a tripod, &c., such as used for the plaster bandage, is available, the patient should swing herself from it for about five or ten minutes every morning, just lifting herself from the ground. Cold bathing, particularly cold sea-water bathing, is of great use. The patient should not sleep on a feather-bed but on a firm mattress, and should rise early.

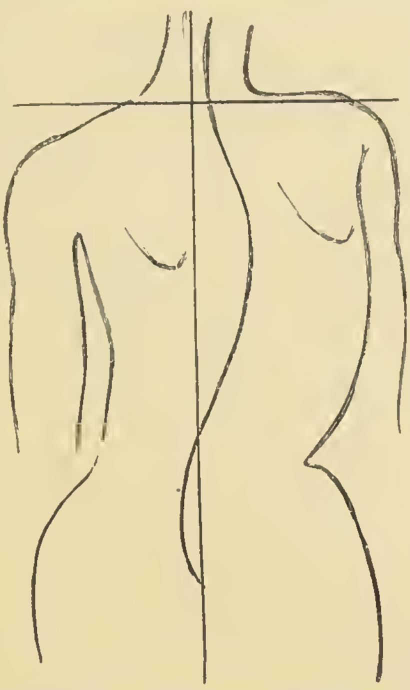


Fig. 32.—Lateral Curvature of the Spine.

RICKETS.

This is essentially a disease of childhood, and makes its first appearance when the child begins to walk, about the eighteenth month after birth. It may come on in any of the earlier years of childhood, but it never occurs after twelve years of age. It is particularly the children of old or feeble parents, or the later children of a large family, and the children of the poor, ill fed, and living in small, badly-aired, and ill-lighted houses, that are most liable to the disease.

Its **causes** are feeble or scrofulous constitution, and insufficient or artificial food, wanting in the necessary accessory foodstuff (see Vitamines, Vol. II., p. 141), and want of fresh air and light.

The chief defect in the bone is absence of the due proportion of animal and mineral matter, the mineral matter—lime salts—being deficient, so that the bones are soft and yielding. Besides this the process of development in the bones is more slow than is usual, and some stages of it are exaggerated, so that not only is there diminished quantity of lime salts, but also increased formation of the soft material, viz. cartilage cells. When at last the bone salts begin to be deposited the formation of bone is apt to advance with greater than normal rapidity, and to extend further than usual, so that the bone becomes denser and heavier than ordinarily.

The **chief sign** of rickets is the deformity which the soft and yielding nature of the bones occasions. As soon as the child begins to walk, the bones of the leg are unable to support the weight of the body, and so bend outwards. The pelvis, similarly, is crushed in by the weight of the backbone and its cavity narrowed. This is specially serious in female children, for the pelvis retains its contracted form up to adult life, and so may obstruct or render impossible natural child-birth. The chest may be deformed, the sides drawn in and the front projected, forming the **pigeon breast**. On each side of the chest, a little to the side of the breast-bone, a row of bead-like nodules is formed, the **rosary**. The bones of the head also partake of the disease, producing the peculiarly large head and protuberant forehead, while the face is small and peaked. In addition, the spine may also be curved, the joints are large and prominent, especially those of the wrist and ankle, causing the appearance called by some people "double-jointed," the growth over the whole body is generally stunted, so that the stature is small, the face is pale, and digestion imperfect. The child is often pot-bellied; the soft spot on the top of its head in front is larger, and later of closing, than usual; and teething is delayed.

In its early stages the disease frequently reveals its onset by the restlessness of the child during the night, a tendency to kick off the bed-clothes, and profuse perspiration about the head, and a painful sensitiveness over the whole body, so that the child objects to be touched. About the age of fifteen the bones often become quite firm, and a process of repair sets in, by which the hollows in the bones due to the bending may become filled up. Thereafter the excess of bone may be absorbed, and so the deformity become greatly diminished.

Treatment must supply defects in the diet, causing the disease, by substituting natural for artificial foodstuffs, especially fresh milk and eggs, by exercise, and by attention to the clothing to see that it is clean and warm, flannel being preferred. Change of air and sea-bathing are very valuable. As to drugs, the best are cod-liver oil and chemical food, given thrice daily in quantities to suit the age of the child, and iron, of which the most suitable form is dialysed iron, 5 to 10 drops four times daily in water.

To prevent the growing deformity of the legs various contrivances exist. The simplest is a wooden splint well padded and strapped on the outside of the leg from the thigh to the foot, which keeps the leg straight and strengthens it till it becomes able to bear the weight of the body. There are others, more complicated, made of steel fastened to the boot, and jointed at the knee so as to permit of bending. These are specially useful when the yielding is mainly at the joints, and not so much due to bending of the bones. There is now in use an operation for curing deformity due to the bending. It consists of cutting out a wedge-shaped portion of the bone, and then fixing up the limb, straight, as for fracture, and keeping it thus till the ends have completely united. It is employed only after the bones have become hard.

SOFTENING OF BONE
(*Mollities Ossium*).

This is peculiarly a disease of elderly women, especially those who have had large families. It consists in a softening of the bone owing, seemingly, to the lime salts being dissolved out of the bones, and then cast out of the body in the urine. It affects usually nearly all the bones of the body, but specially those of the pelvis.

The **signs** are those of general ill health, the patient complaining of weakness and weariness, and specially of aching pains over the body, settling down in the bones about to be affected. The bones grow soft and readily break, turning in bed being sometimes sufficient to cause fracture. The patient becomes bedridden, and may continue so for years till sheer exhaustion ends the suffering.

The **treatment** can only be general—nourishing food, cod-liver oil, rest, and warmth—no special treatment being known that is of any avail.

TUMOURS OF BONE.

These are outgrowths from the bone, and may consist of fibrous substance, of cartilage, of bony substance itself, or of cancer.

The **Fibrous Tumour** is usually connected with the periosteum, especially of the jaws.

The **Cartilaginous Tumour** has its favourite seat on the fingers and toes, and the great toe in particular. It is a heavy, round, smooth tumour of varying degrees of consistency. When it occurs within the bone it usually bursts it up, and this is accompanied with great pain. It is sometimes associated with cancer.

Bony Tumours usually consist of a simple increased development of ordinary bone, either spongy bone, or hard and compact; and sometimes it is of ivory hardness.

The most common form is called **exostosis**, and is found at the ends of long bones near the joints. It also forms readily in connection with the skull, inside or outside. When it is within it may produce convulsions, insanity, and other nervous diseases. The outer angle of the eye is another seat of exostosis. A bony tumour is generally inconvenient and awkward, owing to its size or position, but, with the exception of that of the skull, not hurtful unless it presses seriously upon nerves or blood-vessels.

Bones are the frequent seats of **cancer**, the upper jaw, the lower end of the femur and upper end of tibia and fibula being peculiarly liable. The cancer may begin within or without the bone. When it begins within, it causes wasting of the bony substance around till it is covered by only a fine shell of bone, which at last breaks, and a fungus-like mass sprouts out. It is characterized by rapid growth, by severe, wearing, rheumatic pain, disturbing the sleep.

The **treatment** of bony tumours need only be alluded to. Those that are harmless, such as fibrous, cartilaginous, and bony, had better be left alone unless they come by pressure to cause serious disturbance. If interference become necessary amputation is generally required. With cancer amputation is the only possible treatment.

DISEASES OF THE JOINTS.

INFLAMMATION OF JOINTS.

The most delicate part of a joint is the synovial membrane, which pours out the synovia or fluid lubricating the joint (p. 64). It is liable to inflammatory changes, in which the amount of blood flowing through the vessels of the membrane will be increased, the membrane will be swollen to some extent, and the amount of fluid it pours into the joint will consequently be augmented. This constitutes the commonest form of joint inflammation.

Inflammation of the Synovial Membrane (*Synovitis*, *Dropsy of Joints*).—The inflammation may rapidly subside, and the excess of fluid be absorbed. On the other hand, it may proceed to a more severe form, when the membrane becomes very full of blood, and greatly swollen, the edges being fringed with pulpy deposits formed by the material poured out by the blood-vessels. Suppuration may occur, and the fluid of the joint become mixed with matter, or a regular abscess may exist in the joint, while the ligaments become thick and swollen. The disease may extend to the cartilages, producing dulness and cloudiness of their substance. In chronic cases the cartilages are more seriously concerned, the continuance of the inflammation causing them to become softened or ulcerated, or parts of them may die so that they may be peeled off in large or small pieces, the bone they cover being also affected. The condition in which the synovial membrane has passed into pulpy degeneration is called **white-swelling.**

Symptoms.—Corresponding with this difference in the severity and acuteness of the attack is the nature of the symptoms. In the simple acute case you may have an otherwise healthy man complain of a stiffness of his joint—generally the knee-joint. The joint is seen to be swollen, and if one hand rest on one side of the joint and the other side be tapped by a finger of the other hand a feeling of a wave passing through the joint will be experienced. This is called *fluctuation*, and signifies the presence of fluid in the joint. This accumulation of fluid invariably alters the shape of the joint—an alteration which may easily be observed by comparing the affected joint with the sound one of the opposite side. The swelling is most prominent at the least-covered portions of the joint: in the knees it is seen at each side of the patella, which is projected forwards: at the elbow-joint it is above the olecranon process, and between it and the projection on each side of the arm-bone: in the case of the ankle the fulness is at each side of the joint. There is some pain, but little fever or serious general disturbance. In the severe cases of the acute form, however, the pain in the joint is very great, and aggravated by the least motion. The swelling is great, the skin over the joint being red and tender; and the fever is often very high and severe. The patient lies in bed with the leg bent and turned outwards, and all the muscles are on guard, as it were, to prevent any change in that position. The swelling and puffiness extend to the leg. In the chronic forms, where the cartilages are ulcerated or partly dead, besides a dull, aching pain, worse at night, and swelling, &c., there will be sudden startings of the limb, which may occur while the patient is asleep and awake him. This is always a symptom characteristic of degenerative changes occurring in the joint. The occurrence of shiverings, a high range of temperature, and severe sweating indicates the formation of an abscess in the joint. In abscess as well as in ulceration the matter may burst through the joint, work its way among the soft parts to the surface, through which it breaks, and an opening or openings are left from which the matter escapes.

The **causes** of the disease are exposure to cold, blows, strains, wounds, or mechanical injuries. Besides these purely local causes, there are others which are constitutional, such as rheumatism, gout, venereal disease, and blood-poisoning (pyæmia).

The **treatment** depends on the acuteness of the attack. In the simple case, first mentioned, rest, the knee being supported on a soft pillow, and hot fomentations, will likely be sufficient. To promote the absorption of the fluid, painting with tincture of iodine or the placing of small blisters round the joint is all that is necessary. In severe cases, to ensure absolute rest, the limb must be put up in splints. A long one, carefully padded, should stretch beyond the joint both ways, and be fixed by straps at some distance from the joint. Then put on six to twelve leeches round the joint, and hot fomentations a short time afterwards. It is often better, especially if the inflammation is the result of a wound and has lately occurred, to put at once a large ice-bag over the joint. In such a case pound the ice, put it in an india-rubber bag, and place it over the joint, *having a moderately thick piece of flannel between the bag and the skin.* The ice-bag may be kept applied for hours in this way. Then give purgative medicine, Epsom or seidlitz salts being preferable. At night twenty-five drops of laudanum may be given to relieve the pain *if the person be an adult.* When the acute stage has passed away the swelling is to be got rid of, as before, by blisters, iodine paint, and the pressure of a tightly and well applied bandage. Splints must not be left too long on, lest the joint become permanently stiff or its range of movement interfered with by the formation, within the joint, of bands of new tissue crossing it and preventing movement in certain directions. The stiffness or partial union of a joint by such bands is termed **false anchylosis.** To prevent it, as soon as the splint can be taken off, which time can only be judged of according to the patient, the joint should be manipulated by some one and moved gently backwards and forwards for a few moments several times a day.

Where disorganization of the joint (**white-swelling**) has taken place the limb must be kept straight by the splint, and the patient's strength supported by food, cod-liver oil, &c., in the hope that the joint will become permanently fixed, which is the best cure to be looked for in the case. A surgical operation, and even excision of the joint may be necessary.

Permanent rigidity of a joint is called **true anchylosis.** When it is sought for as the best cure care ought to be taken to place the limb in the most favourable position for use after union has taken place. This position, for the hip and knee, is straight, for the elbow it is at a right angle.

Where an abscess has formed in the joint an opening should, of course, be made to permit the matter to escape.

When the inflammation is due to rheumatism, gout, &c., the treatment for these diseases should be adopted. (See RHEUMATISM, GOUT, &c.)

Chronic Rheumatic Inflammation of Joints (*Chronic Rheumatic Arthritis—Rheumatic Gout*) occurs frequently in elderly persons, generally women, though it may follow an acute rheumatic attack in the young. In it, it is, in the main, the soft tissues round the joint, the ligaments and tendons, that are involved. Recurring inflammatory changes produce thickening, and contraction and hardness of these soft tissues. In consequence the joints become stiff, and movement becomes restricted, and accompanied by pain if an effort is made to overcome the stiffness. With long continuance of the condition the bones become fixed in a deformed position. Frequently also the joint is deformed by painful soft swellings, somewhat sausage-shaped, which, when an attack recurs, become larger and more swollen. These are due to bursæ (see p. 119) over the joint, or the sheaths of tendons passing over or to the joint, which are inflamed and dropsical.

Symptoms.—Pain is the chief symptom, worse in damp and cold weather—pain that is racking, wearying, gnawing. The joint is stiff, and its movements often accompanied by a peculiar creaking sound. There are frequent recurrences of swelling and heat with increase of pain.

Treatment.—The best local remedy is heat applied by fomentations, or, best of all, hot baths—vapour or Turkish, or the dry heat or electric-light bath. M. Gueneau de Mussy strongly recommends arsenical baths made in the following manner:—15 grains of arseniate of soda, with ¼ lb. of carbonate of soda, are added to 30 gallons of water at a temperature of 98° Fahr.; and twelve such baths are taken —for the first four every second day, and afterwards daily, the patient remaining in the bath for from seven to ten minutes. These baths sometimes produce marked improvement, the suppleness of the joints increasing after every bath; sometimes slight diarrhœa, temporary excitement, and sleeplessness result. Sulphuret of potass may be used in the strength of 4 oz. to the 30 gallons of hot water, and the same number of baths taken as above recommended. Sulphur ointment is sometimes used as an application to the affected joints, more especially where a single joint is suffering; or a lotion of equal parts of glycerine and of the tinctures of iodine, opium, and aconite may be used, the joints being wrapped in flannel after the ointment or lotion has been applied.

In young subjects the disease should seldom be permitted to end in fixed or deformed joints. For this can nearly always be prevented by forcible movement of the joint, to stretch the contracted tendons and break down any adhesions that have formed. As a rule it will be necessary to do this under chloroform, and afterwards to maintain the mobility by massage and Swedish exercises.

Damp houses should specially be avoided. The patients should keep themselves warm, and constantly wear woollen clothing.

In reference to general treatment the diet must be carefully attended to, no heavy pastry or puddings made with suet being allowed, plain food being most suitable, at regular intervals, so that the stomach is allowed sufficient rest.

The bowels should also be regulated. For this purpose the natural or the artificial Carlsbad salts may be used. The artificial are made by combining equal parts of sulphate, phosphate, and bicarbonate of soda, of which a tea-spoonful is taken in half a tumblerful of lukewarm water in the morning. Friedrichshall water or Hunyadi Janos may be taken instead of the above, a claret-glassful slightly heated being generally sufficient to produce the desired effect.

The most commonly used medicine is iodide of potassium, of which 3 grains dissolved in water may be taken thrice daily for several weeks. A mixture that has obtained great credit is made of guaiacum, sulphur, and potash, as directed in the recipe for gout. (See APPENDIX OF PRESCRIPTIONS.) The long-continued use of cod-liver oil is also beneficial.

This disease must be carefully distinguished from Rheumatoid Arthritis, a description of which follows.

Rheumatoid Arthritis (*Arthritis Deformans*).—This is a disease which has for a long time been confused with chronic rheumatic inflammation of joints, but which differs essentially from it.

It usually attacks women about the time of change of life. It is often associated with one or other of the diseases peculiar to women, and its commencement is frequently ascribed to anxiety or other depressing mental emotion, such as shock or fright. Several theories are in vogue to account for its production, one ascribing it to some disturbance of the nervous regulation of the nutrition of the joint, another attributing it to a toxic cause, the toxin being produced by some defect in the chemical processes going on in the intestine.

Symptoms.—The disease is of slow progress, and as a rule without fever or other marked evidence. Probably the first thing noticed is the enlargement of the joints of the fingers, an enlargement attended by pain. In time manifest deformity is produced. As a rule both hands are attacked simultaneously, similar joints of each hand being involved. Following the finger joints, the knuckles become involved, then the wrist, elbows, and shoulders. A similar progress occurs when the lower extremities are attacked, as they usually are. The deformity produced by the changes going on in the joints is quite different from that exhibited by the disease with which rheumatoid arthritis is frequently confused. For in the case of rheumatoid arthritis it is the essential structures of the joint that, from the beginning, are involved. Degenerative changes occur in the cartilages of the joint, which end in the opposing surfaces of bone becoming denuded of their protective gristle. The ends of the bones thus exposed become dense and polished like ivory. At the same time, round the edges of the joint surfaces bony outgrowths are formed, which can be felt and seen as hard masses disposed irregularly about the joint. The position of some of these masses may cause locking of the joint, while the greater growth at one part of the joint may cause it to be pressed over into an abnormal position, and so permanent distortion occurs.

The muscles about the joints become wasted, adding to the deformity and difficulty of movement.

If the bones entering into the joint can be moved on one another, a grating or cracking sound may be heard, because the ends of the bones have been denuded of their smooth coating.

The progress of the disease is attended by periodic outbreaks of increasing swelling and pain, which, for the time, totally cripple the patient, while neuralgic pains, muscular cramps, and spasms are frequent.

The disease is one of very slow progress, and does not itself kill, though the worry and continual discomfort may, by impairing the general health, render the patient a more easy prey to some other disorder.

It is most important to distinguish between this disease and that just previously described, because the latter is a curable disorder, if treatment be judiciously carried on from the beginning, while true rheumatoid arthritis is little amenable to treatment. Another reason for carefully distinguishing is, that the subjects of rheumatoid arthritis require generous stimulating diet. Lastly, the forcible methods of breaking down adhesions in chronic rheumatic joint affections would never be adopted in rheumatoid arthritis.

If, therefore, there is any difficulty in arriving at a decision, the affected joints should be examined under the Roentgen rays and a photograph taken. The changes in the joints themselves, which occur in the disease we are discussing, cannot fail to print their evidences on the photograph, while in chronic rheumatic affections, in which the soft tissues are involved, the bones will be found normal.

Treatment.—Liberal diet is necessary, and the use of stimulants at meals is permitted, of course in strictly regulated quantity. Full doses of cod-liver oil should be taken after meals, along with the syrup iodide of iron, the latter up to a tea-spoonful, and even more if the stomach is undisturbed by it. Daily warm baths are most useful, specially warm baths accompanied by manipulation, as in the Aix-douche, or Vichy baths, which, of course, are best obtained in special resorts like Aix-les-Bains, or Cauterets, in France, Spa in Belgium, Harrogate, Woodhall, Droitwich, &c.,

in England. Ordinary Russian or Turkish baths are also useful, or warm pine baths, sulphur baths, mud baths, salt-water baths, but neither cold baths nor sea-bathing. If the patient can afford it, she should select a well-conducted spa, where, besides such baths, electrical treatment can be obtained, and the treatment by high temperature, such as the Dowsing or similar system of electric-light bath affords. Acute outbreaks may be relieved by salicylate of sodium, or salol, in large doses, 15 grains every 2 hours, though this, as a rule, can be maintained only for 4 or 5 days continuously.

Hip-joint Disease (*Morbus Coxæ*). The nature and progress of this disease are the same as those described under Inflammation of Joints. The hip-joint, however, is most often attacked, and particularly in children. It is a disease very often overlooked in its early stages, when it is most easily treated, and therefore should be specially noted. It is a tubercular disease, though it may be apparently begun by an injury.

Symptoms.—The child is affected with slight lameness, and drags one leg. This is most noticeable, in the very earliest stage, in the morning, passing off with exercise, and later, it is worst in the evening after the fatigue of walking or standing all day. When the child is stripped, placed standing on a chair, and is looked at from behind, the pelvis of one side is seen to be drawn up and only the toes of that side touch the ground, or the foot is turned on edge and rested on the side of the other foot. When the child is laid on its back on a firm, flat surface the affected limb is bent at the knee, while the sound one lies straight out. When the bent knee is pressed flat on to the ground, the back at once becomes arched. If the child be then turned on its face the buttocks of the affected side seem flattened and wasted. In the beginning the pain is often slight and occasional, then it increases, and may be felt all over the thigh. In the later stages it is often felt chiefly at the knee, and this is apt to draw away attention from the hip. The pain may be brought out by pressing behind the trochanter—the projection of bone felt at the side of the hip—or in front over the joint in the groin. The most delicate test for the pain is to lay the person on the back, take the foot in the hand, the leg being bent at the knee and the thigh being bent up towards the body, the limb being at the same time turned away from the middle line, and in this position turn the foot gently outwards. The muscles usually fix the limb so as to prevent movement at the affected joint.

Besides these special symptoms, those of starting at night, &c., already mentioned under Inflammation of Joints, are present.

Treatment.—The treatment already described for diseased joints—splints, cod-liver oil and tonics, &c.—is applicable here. But it is necessary also to keep the joint at rest, and remove the pressure from the head of the bone. This is done by continuous extension (Fig. 33). A broad strip of adhesive plaster (*a*) is applied to each side of the lower part of the leg by its ends in such a way that the long loop of the plaster extends beyond the heel. The strip is secured by bands of plaster (*c*) round the leg. The loop is attached to a square piece of wood placed under it, and resting against the sole of the foot. From the centre of the wood stretches a cord (*b*) which passes over a pulley (*d*) attached to the foot of the bed. From the end of the cord hangs a weight (*e*) sufficient to keep up extension of the limb. The amount of weight is best judged of by the patient himself, but it should not be less than 10 lbs. It may be slowly increased, and should be kept on night and day. While this treatment is going on strengthening food, &c., must not be forgotten, and if possible an arrangement should be made whereby the child may lie, most of the day, in the open air, specially inland and on high ground.

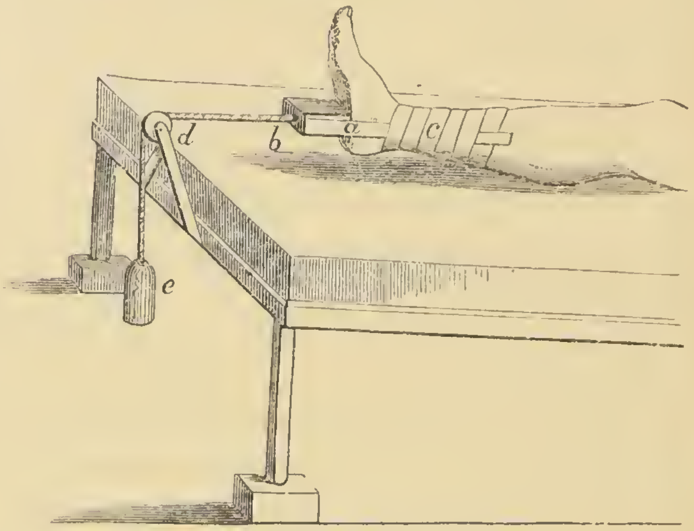


Fig. 33.—Continuous Extension.

Housemaid's Knee See p. 122.

HYSTERICAL AFFECTIONS OF JOINTS.

These are not uncommon in girls from twelve to fifteen years of age, and in women at the middle period of life, in persons of nervous temperament. Frightful pain is complained of, but the joint presents no redness, swelling, &c. to account for it. One must not be deceived by appearances, which may have been produced by poultices, blisters, or liniments. The general health remains excellent in spite of the serious complaint; sleep is not disturbed. It will usually, however, take a skilful surgeon to determine whether it is a case of hysteria or actual disease. The treatment must be directed to the nervous condition. (See HYSTERIA.)

INJURIES OF BONE.

FRACTURE.

General Considerations.—A fracture is a break in a bone.

Its **Causes** are of two kinds—Predisposing and Exciting.

Predisposing causes include the *age* and *sex* of the patient. In youth the animal matter abounds, so that bending is more likely to occur than breaking. In old age the mineral matter abounds, and, therefore, the bones are more brittle. In infancy, accordingly, the number of fractures is less than at any other period of life. The number increases about the ages of seventeen and twenty-five. The greatest number, however, occurs after forty. Men are more liable than women.

Constitutional diseases increase the liability, such as scurvy, syphilis, and especially rickets.

Local diseases, that is, diseases affecting the bone itself, such as inflammation, tumours, softening, ulceration, wasting, predispose by diminishing the resistance of the bone.

Exciting causes are those which actually produce the fracture, and are of two kinds—(1) *Violence*, (2) *Muscular Contraction*. (1) The *violence* may be applied to the limb directly or indirectly. Thus when a cart-wheel passes over a man's leg it breaks the bone by direct violence; a blow from a stick breaking an arm would also be a case of direct violence. But when a person jumps from a height, though he lands quite rightly on his feet, he may break one of the bones of his leg by the shock communicated upwards. This would be indirect violence. Similarly, a man thrown from his horse frequently breaks his collar-bone, though nothing has touched the clavicle itself. (2) *Muscular contraction* is not, of course, so common a cause of fracture. It is the severe muscular contractions that occur in fits that are most liable to do this. Violent coughing in old people may break some of the ribs; and this would be a case of muscular contraction.

Kinds.—(1) **Simple.** Here the bone is merely broken at one point, straight across or in a slanting direction.

A simple fracture may occur either in the shaft of the bone or at the extremities. When it occurs at the extremities it may separate the ends—epiphyses—from the shaft, with which they have not yet been completely united. This can happen only in persons whose development has not been completed. It is never found after fifteen, and seldom after eight, years of age. Separation of epiphyses is called **diastasis.**

(2) **Compound.** This implies not only that there is a bone broken, but also that a wound exists *which leads down to the break from the outside.* It is not sufficient that a wound exists in the neighbourhood of the fracture; it is only where that wound opens externally and communicates with the place of fracture that the case is properly one of compound fracture. Now this wound may be made in two ways: (*a*) from without, as when the violence applied outside has both caused the wound and produced the fracture; and (*b*) from within. In the latter case the jagged ends of the broken bone may, by movement, have been forced through the muscles and skin. Again, an abscess may have formed at the seat of fracture, and the matter may have burst out and so made an opening. Or the ends of the bone may not have been properly set, and may have pressed against the soft parts, causing an opening by ulceration. Compound fracture, where the wound is due to the bursting of the jagged ends through the tissues, is likely to be less dangerous than that in which the wound has been produced from without. For, in the latter case, the damage done to the soft parts is liable to be more extensive.

(3) **Comminuted** fractures are those in which the violence has been sufficient to break part of the bone into fragments. A comminuted fracture may also be compound, that is to say, the bone may have been broken to pieces, and a wound may exist leading from the seat of fracture to the outside.

(4) **Green-stick** fracture is the name applied to the incomplete break occurring frequently in the bones of children. If a fresh sapling be violently bent it will break only half-way through, one side being broken, the other only bruised. So in children the bones are soft and pliable, and one side, the convexity of the bend, may be broken, the other only bruised.

(5) **Impacted fracture** occurs at the end of long bones when the shaft is driven up into the head of the bone. In such a case some of the signs of fracture are absent. There will be no unnatural degree of movement, for example.

Mode of Union.—The first step in the process of repair consists in the pouring out from the blood-vessels of the bone and its outer and inner lining membranes of a fluid and cells capable of forming a consistent tissue. This tissue becomes at first fibrous, then cartilaginous, and finally is transformed into bone. The material which thus unites fractures is called **callus.** When the fragments have not separated from one another, but remain in their proper position, the callus is formed only between the two ends, where it is called **permanent callus,** and, as **internal callus,** in the marrow cavity, which it completely fills up. But when the bones have separated, and have not been properly replaced, the repairing material is exuded from the blood-vessels in sufficient quantity to fill up the gap between the two fragments, and to surround the two ends completely so as to form a clasp. When this has become converted into bone a bridge of new bone connects the fragments, and a ring of new bone encircles them for some distance above and below the place of fracture. The portion that acts the part of ring does not remain permanently. It exists for the purpose of keeping the broken bone at rest until a union has been accomplished between the ends. When that has been effected much of the encircling callus is absorbed. For this reason it has been called **provisional, external, or sheathing callus.** The time which elapses before complete union has taken place varies according to the age and strength of the person, and also according to the size of the bone, the accuracy of the adjustment of the fragments, and the degree of perfectness of rest permitted to the part. The usual time, however, is from four to ten weeks. But the process does not end here. As soon as rigidity has been obtained the sharp edges of the bone begin to be smoothed away, and any bone that has been formed in excess of what is necessary for purposes of union is slowly absorbed. By absorption also the inner layers of new bone change from dense to spongy bony tissue, and the marrow cavity is cleared of its internal callus. The last stage may be completed in from six to twelve months.

Non-union.—Some bones do not readily unite at all by bony union. They are generally bones which, from the position they occupy, and owing to the action of the muscles attached to them, do not get sufficient rest to permit of the reparative process going on in all its stages. As a result the callus never reaches the stage of true bone, but stops short at the fibrous or gristly stage. This is specially liable to occur in repair of the neck of the thigh-bone, the olecranon process of the ulna, the processes of the shoulder-blade, and very particularly the knee-pan. In the union of any bone, however, such an arrest of development may take place. It may be that the person is not in vigorous health, and therefore the repair is tedious or incomplete. Frequent meddling by the attendant, or constant movement by the patient, will produce a like result. The occurrence of suppuration or death of a portion of the bone, a thing likely enough to occur in a compound or comminuted fracture, would also interfere with perfect repair. In such cases ligamentous may take the place of bony union, or the ends of the bone, remaining separate, may become rounded off, covered with a glistening fibrous tissue, and inclosed within a kind of fibrous sheath, so that a **false joint** is formed, which permits of free movement.

Signs.—Naturally the first signs of fracture are *pain* and *loss of function*—the person cannot use the broken limb. In a short time there will also be *swelling* and *discoloration*, due, first of all, to the blood from the torn blood-vessels, and, next, to the material that exudes from the vessels for repair. It is of great value to be able to examine the limb before the swelling sets in, as it may mask some of the most important distinguishing signs of fracture. The most important signs are—(1) *unnatural capacity of movement* at the site of the fracture; (2) a peculiar crackling sensation called *crepitation*, which may be felt by the hand placed over the fracture, when the opposed surfaces of the broken bone grate upon each other; (3) *deformity*, caused by the displacement of one of the fragments. (1) The unnatural power of motion is most generally present, though when the break is near a joint it may be difficult to distinguish it from the ordinary movement of the bone in the joint. It is one of the main distinguishing features between fracture and dislocation, the limb being, in the latter case, deprived of its natural power of movement. (2) Crepitation is obtained by trying to move one end of the broken bone on the other, and conveys a sense of rough, coarse grating to the hands. It cannot be discovered if there be any degree of swelling; it may not be obtained when the broken bone is alongside of another, which supports it and prevents the necessary movements. For instance, if, in the forearm, the radius were broken, the support of the ulna would prevent crepitation. (3) Deformity is, above all others, the most important sign. Deformity is due to displacement, generally of the more remote of the two fragments. The displacement may have been effected at the moment of fracture by the violence which caused it. It is frequently produced by the muscles attached to the bone, the natural tension of the muscles causing them to pull away the part, and making it project in some unusual manner. The weight of the fractured limb, beyond the injured part, is also a frequent cause. Thus, if the thigh-bone be broken, the foot will act as a lever, displacing the lower fragment outwards. The displacement may be of different kinds: (*a*) Displacement by riding, in which one end lies over the other. (*b*) Angular displacement, where the two ends are not in the same straight line, but form an angle. (*c*) Displacement by turning. An instance of this has been given already, viz., in fracture of the thigh-bone the weight of the foot turns the lower fragment outwards. There is, therefore, rotation of the lower fragment. (*d*) Lateral displacement, in which one fragment moves to the side of the other, keeping parallel with it, and without losing its grip of the other fragment. Most of these displacements can be conjoined. Thus riding can coexist with rotation, &c. Besides the signs already mentioned, another may be noted, viz. *shortening* of the fractured limb. This is not always present. When it does occur it is due to displacement, one fragment overriding the other and so causing the apparent shortening. To detect this, as well as to detect swelling and deformity, a comparison must be instituted between the sound limb and the limb supposed to be broken, and measurements taken to determine any difference in length.

In *impacted fracture* unnatural movement and grating will be absent, and deformity and shortening will be the chief signs.

Distinction between Fracture, Dislocation, and Bruise.—It has been said that in dislocation the movement is diminished instead of increased, the dislocated bone being unnaturally *fixed;* and there is no crepitation. In a bruise there will be pain, swelling, and loss of function as in fracture, and the swelling may be so great as to prevent a proper examination. In such a case the limb should be kept quiet, supported, and hot cloths applied till the swelling subsides. Then it will be found that if there be merely a bruise and no fracture, there will be no unnatural motion and no crepitation.

Treatment.—*Temporary Treatment.* It often happens that a person receives a fracture and has to be carried some distance before being regularly attended to. In such a case it is extremely desirable that the broken limb should be so fixed that dangling is prevented and no movement permitted. If this is not done there is great risk that the ends of the broken bone, moving about freely among the muscles, nerves, and blood-vessels, may do damage much more serious than the original break, and may even force their way through the tissues, causing a wound, and so converting a simple into a compound fracture. To prevent this is easy. The limb should be rendered immovable by placing on each side something rigid. A walking-stick or umbrella, in the absence of anything else, would do. Bark stripped from a tree, pieces of wood torn from a paling, and so on, would, for the time, equally answer the purpose. Whatever is employed should be secured by straps, which may be obtained from handkerchiefs, or strips of cloth torn from some article of clothing. Then, if the thigh or leg has been broken, after it has been rendered immovable in this way the person should be placed on a stretcher, or whatever can be got in its place, in such a way that the *whole* of the injured limb is supported. If, for instance, the foot and part of the leg were left projecting beyond the stretcher, they would act as forces dragging the broken parts asunder, and every step of the carriers would communicate great pain to the sufferer. In order further to support the broken leg it might be placed alongside the sound one and strapped to it.

Systematic Treatment.—There are two main conditions to be fulfilled in the treatment of fracture: the first is to restore the bone to its natural position, and the second is to retain it in that position till it can have time to heal. (1) Restoring of the bone to its natural position, or the **reduction of the fracture**, is best effected by considering what are the forces that tend to displace the bone. The forces are particularly muscular, and it is, therefore, necessary to grasp the limb—that part of it which carries the lower fragment—and pull it firmly but steadily in a direction opposed to the muscles that displace and in the axis of the limb. This is called **extension**; and, along with it, what is termed **counter-extension** must be employed, which consists in fixing the upper fragment so that it may not be pulled on also, and may afford a firm position from which the lower fragment may be extended. As soon as sufficient extension has been practised the ends of the bone must be brought together, so as to fit as accurately as possible. It is done by keeping the upper fragment fixed, and bringing the lower one into the same straight line, so that the proper relations between the two may be restored. This is **coaptation or setting.** It is sometimes rendered difficult by splinters of bone preventing the proper adjustment of the two ends, and in all cases *is not to be accomplished by force, but only by careful working by the hand.* Fracture differs from dislocation in the ease with which the bone can be returned to its proper place in fracture, and its difficulty in dislocation. But there is another difference, that, namely, after a fractured bone has been reduced, as soon as the extending force has been withdrawn, the displacement tends to return; and in dislocation, though the reduction is difficult, it is permanent. Therefore in fracture there is the necessity of some means of retaining the bone in position, once the reduction has been effected. This is accomplished by mechanical means—by the use of splints made of wood, pasteboard, or other stiff material, to which the limb is strapped. The splints ought to pass from the joint immediately above the fracture to the joint immediately below, and are usually placed on each side of the limb. The splints are fitted more accurately by the use of pads, and are secured by bandages. So well should they fit and so tightly ought they to be secured, that not the slightest movement can be effected between the opposed ends of the broken bone. Such movement, if permitted, is one of the commonest causes of non-union of fracture. At the same time care must be taken that the bandages do not unduly or irregularly compress the soft parts of the limb or interfere with the circulation of blood in it. The person ought to be laid upon a firm mattress, soft beds being hurtful, and the limb ought to be equally supported on the bed, so that no undue weight is on any part of it. From time to time an examination must be made to see that the broken parts retain their position; and this ought to be done without disturbing the splints or their fastenings. The splints ought, for this purpose, to be kept applied to the limb by straps independently of bandages, so that if the bandages require to be removed the fixture of the splints is not interfered with. (For bandaging, &c., see p. 558, Vol. II.)

As the result of fracture there may be some degree of fever and inflammation. To combat these the patient should first of all get some opening medicine, of which salts, seidlitz, &c., in fact saline medicines, are the best. To the part, if inflamed, cold water cloths may be applied; and to allay pain one-grain doses of opium may be administered at night, but *only to an adult.*

After the fracture has been kept in splints for several weeks there is risk of the joints in the neighbourhood becoming stiff and fixed. To prevent this, as soon as is consistent with the union of the fracture, four, five, or six weeks after it has been received, the bandages and splints should be undone, and the joint exercised gently by the hands. Rubbing the joints, bathing frequently with hot and cold water, will help this. The place of fracture itself should be guarded by small splints placed immediately over it, or by supports of some other kind, such as stiff bandages. An ordinary leather plaster, heated and placed round the seat of fracture, is a simple and efficient means of doing this.

Compound fractures are often very difficult to treat, and are very dangerous kinds besides. If it is the end of the broken bone that made the wound, and if the bone is still protruding, there is often great difficulty in reducing the fracture. When reduced the fracture ought to be so put up that the wound is left free and open, so that it may be properly and frequently dressed. The wound should be carefully washed with water which contains carbolic acid (one part of the acid to sixty of water), and a piece of lint dipped in this solution ought then to be laid over the wound, the lint being covered by gutta-percha tissue and secured by a bandage. The dressing should be renewed every day or second day. There are various complications which may readily arise in connection with compound fractures, but they are of such a character that only qualified surgeons can deal with them, and therefore it is needless discussing them here. A serious complication is the wounding of an important blood-vessel by the ragged end of the bone and great consequent loss of blood. The bleeding may be temporarily arrested by applying over the wound a thick pad and binding it tightly on with a bandage or handkerchief. (See chapter on ACCIDENTS AND EMERGENCIES.) Amputation is frequently necessary to save life. When a fracture has united crookedly it may to some extent be rectified by a surgical operation.

FRACTURES OF THE SKULL.

Fractures of the bones of the skull are, as a rule, so difficult of detection and require such skilful treatment that a surgeon's advice and attention are always necessary. A brief reference, therefore, is all that is required here.

The usual places for fractures of the skull are the vault or roof, and the base. The vault is usually broken by a direct blow, the base of the skull indirectly. Thus when a man is struck on the top of the head with a stone or stick, that is, by a sharp concentrated blow, fracture of the vault is likely to occur; but when a man has fallen from a height upon his head, or when his head has been caught between two opposing forces, it is the base that is commonly the seat of fracture. Fracture at the base also occurs by a person falling from a height and landing on his feet or in the sitting posture, the force, being transmitted up the back-bone, causing the break to occur.

The bones of the skull consist of two plates of dense bone, one without and one within, and a layer of spongy bone—the diploe—between. Now a fracture may consist of a crack or fissure, or of a breaking inwards of one or other of these dense plates, or of both together.

In **Fractures of the Vault** the forcing inwards of one or other or both bony plates is the most common form. Thus, there may be simple fracture or fracture with displacement, and as the displacement is almost invariably inwards it is called **fracture with depression.** The broken bone may be depressed in a piece, or it may have been broken into fragments and the fragments driven inwards. The fracture may or may not be accompanied by a wound.

The **symptoms** are not easy to make out. If it is a simple fissure there may be no signs of any moment. When the bone has been depressed, the hollow may be made out by careful examination with the fingers after shaving the part. The hollow will be surrounded by a projecting ridge. Care must be taken not to confound this feeling of a depression with the sensation caused by a mass of blood-clot forming within the scalp, which will yield to firm pressure with the finger. Where a wound exists the forcing inwards of the bone will be more easily made out, and examination with a probe will reveal the mischief more fully. It must be remembered, however, that the inner table may be splintered and depressed and little corresponding injury be present in the outer table.

The **treatment** consists in putting the patient to bed, keeping him lying on his back, quite quiet, applying cold-water cloths to the head, and giving opening medicine. The fall or blow may have brought on unconsciousness, in which case the patient is simply to be kept quiet, and to be made warm by clothing and the application of heat to the feet. If consciousness does not soon return, and if the breathing is slow and laboured, the skin cold, and the pulse weak, a serious condition of the brain is indicated, due, likely, to depression of bone. This can be remedied only by raising the depressed bone, which no one but a surgeon can undertake to perform.

Fracture of the Base of the Skull is usually determined by the kind of injury, by bleeding from the nose and from the ear, and by the oozing from the ear of a clear fluid after bleeding has ceased. This fluid comes from the membranes covering the brain, and is a very sure sign of fracture at the base of the skull. There may be other symptoms present, such as deafness, drawing of the face to one side owing to paralysis of the other, inability to swallow, and other signs due to injury of certain nerves. The eyes also may be completely bloodshot. There is likely to be extreme stupor, quick pulse, hot skin, and maybe delirium.

Treatment consists in perfect quiet and rest, shaving the head, and applying cold-water or iced cloths, giving opening medicine and low diet.

Fracture at the base of the skull is very fatal.

FRACTURES OF BONES OF THE FACE.

Fracture of the Nasal Bones is frequently produced by blows or falls. The swelling and discoloration are likely to be great, and depression of the bones will usually indicate the fracture, the bridge of the nose being broken down. There may be severe bleeding, and headache is likely to result from the accident.

The **treatment** consists in trying to remedy the depression by the fingers, or by pushing a gum-elastic catheter (see Catheter—Medical and Surgical Appliances) carefully up the nostril and trying to replace the bone from within. If the bleeding is excessive it should be stopped by pushing plugs of oiled lint up the nostril. The swelling and headache are to be met by cold applications, and purgatives of some kind of salts. *Some time after* the injury hot cloths will give more relief than cold applications, though cold is the proper remedy *immediately on receipt of the injury*, since it tends to arrest bleeding, which heat would only encourage.

Fracture of the Lower Jaw is not uncommon. It also is due to violent blows or falls; a throw from horseback might easily produce it. The break usually occurs towards the front in the neighbourhood of the eye-teeth, a little to the right or left of the middle line. It may be on both sides, so that a portion of the bone, carrying one or two teeth, is entirely separated from the rest, and held in position only by the soft parts.

Signs.—The fracture is usually easily recognized by the unnatural power of movement of the part, the grating (crepitus) when the parts are moved against one another, and the irregularity in the line of the teeth. There are also pain, swelling, and inability to move the jaw. The gums are usually torn and bleeding.

Treatment.—The difficulty is to keep the parts at rest, since that implies moving the jaw as little as possible for from four to six weeks, and therefore interferes with eating and speaking. A special splint has to be made of pasteboard or gutta-percha, the latter being preferred, cut to a particular shape, and moulded to fit the jaw after being softened in boiling water. Fig. 34 shows the shape of the splint; the size should be determined by the jaw to which it is to be applied. The long part (*a*) of the splint is applied along the jaw from one side to the other, while the shorter piece (*b*) doubles down under the chin, and should be long enough to permit of its ends projecting from beneath the chin at each side, the projecting ends being then folded up on either side. The gutta-percha should be first cut and shaped to the proper size, taken in paper, and after being thoroughly softened should be quickly applied so that it may take the accurate form of the jaw without trouble. It ought to be kept in position by a four-tailed bandage made of a yard and a half of cotton cloth about four inches wide. The bandage is torn up lengthwise from each end, so as to leave eight inches in the middle, which has a hole cut in its centre to receive the point of the chin. Two of the tails are then brought up, one on each side of the head, and tied over the top of the head; the other two are tied behind the head. The bone must be kept fixed in this way for from four to six weeks. During that period only soft or liquid food should be given, so that no chewing is required, and speech should, as much as possible, be avoided. If the fracture has been attended with much bruising or swelling large soft poultices should be applied, which will be sufficient to keep the parts in position till the swelling subsides, when the splint may be used.

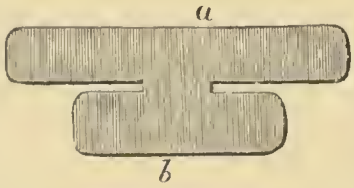


Fig. 34.—Splint for Fracture of the Jaw.

FRACTURES OF THE BONES OF THE UPPER EXTREMITY.

Fracture of the Collar-bone (*Clavicle*). This is a very common fracture, the most common, indeed, with one exception—that of the radius, and is most frequently due to indirect violence, such as a fall on the shoulder. It may be caused by direct violence. It is extremely common in children, in whom, however, it does not always break completely through, but takes the form of *green-stick* fracture. The break is usually near the middle of the bone, but sometimes it occurs nearer its outer end, when it may not be so readily recognized because of certain ligaments which pass from the outer end to the acromion and coracoid processes of the scapula (see p. 62) and prevent the usual displacement.

Signs.—When the fracture is complete the weight of the arm carries the shoulder downwards and inwards towards the middle line because of the loss of its main stay, and because of the action of the muscles passing from the chest to the shoulder. As the result of this the skin and tissues over the seat of fracture are stretched, and the *outer end of the inner fragment* is found projecting. This *is not because of its displacement, but because of the falling down of the shoulder*. To the outside of this projection is a hollow. The outer fragment is carried below the level of the inner one, the two ends often riding. The patient is unable to lift the affected arm, and supports it close to the side. Comparison with the sound side will prove the deformity. In children there may be little or no displacement, either because the fracture is not complete or because the bone has been broken straight across and the outer lining is strong enough to support it. By running the finger along the bone the fracture will be found, irregularity being perceived over the spot where the break is, and pain being experienced by the child at that place.

Treatment.—The displacing forces act downwards, forwards, and inwards; the retaining apparatus must therefore act in the opposite directions—upwards, backwards, and outwards. To replace the bone, place the patient in bed on a firm mattress, with a pillow lying lengthways down between the shoulders. Standing behind the person pull the shoulder upwards and backwards and reduction will be effected. As soon as the reducing force is removed the displacement returns. The simplest retaining arrangement is as follows:—a pad of considerable thickness, made of cotton-wool rolled up in a handkerchief, is placed well up into the arm-pit and the arm folded down over it, the pad being retained by a strap over the opposite shoulder; this forces the shoulder *outwards;* the elbow being kept close to the side, the forearm and hand should be laid across the chest, the fingers pointing to the opposite shoulder and reaching well up towards it; a few turns of a roller bandage right round the body keep the elbow at the side and the shoulder well *back;* the elbow should be supported, and the shoulder pushed and kept *upwards,* by a sling tied over the opposite shoulder. (Fig. 35.) If the pad, sling, and bandage are properly adjusted and the arm placed properly across the chest the displacement should disappear, and this tests the accuracy of the adjustments. Union takes place in three weeks or four, in young people even earlier. The bandages should occasionally be examined to see that they do not become loose. Union does not usually occur without some shortening.

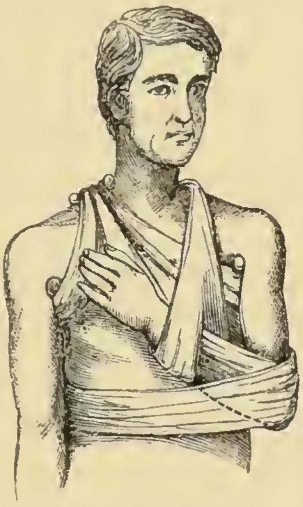


Fig. 35.—Treatment of Fractured Collar-bone.

Fractures of the Shoulder-blade (*Scapula*).—The shoulder-blade is so well padded by muscles that little displacement is, as a rule, produced by fracture. The break is usually due to direct violence, such as the passing of a cart-wheel over the back. Movement and grating are best detected by grasping the shoulder and upper part of the bone with one hand and the lower corner of the shoulder-blade with the other and trying to move them on one another, or by placing one hand flat over the bone and moving the arm in various directions.

Treatment.—This fracture requires no setting because, as already explained, the muscles prevent any displacement. Put a thick pad of wool over the shoulder-blade, or mould a gutta-percha shield over it, retain by a firm bandage, and put the arm in a sling.

Fracture of the Point of the Shoulder (*Acromion process*).—This fracture is usually caused by a blow from above. The deformity consists in the absence of the usual roundness of the shoulder. Compare both sides, and note that on the affected side there is a sudden sinking of the extremity of the shoulder. The process can be felt floating in the hollow. When the arm is raised the fragments may be brought into apposition, and grating is felt, the roundness of the shoulder being restored. The person is unable to raise his arm to any extent.

Treatment.—The acromion cannot be accurately adjusted to the shoulder-blade, and, besides, unites only by ligament. The sole treatment, therefore, consists in keeping the arm well supported by a sling for about four weeks. The patient will never be able comfortably to place his hand on the top of his head.

Other fractures of processes of the shoulder-blade are too rare to be noted here.

Fractures of the Arm-bone (*Humerus*).—The humerus is liable to fracture of the upper end, or head and neck of the bone, of the shaft, and of the condyles or lower end.

Fractures of the Upper End of the Arm-bone are generally produced by a fall on the upper part of the arm, when the shoulder comes into violent contact with the ground.

Signs.—The lower fragment is drawn by muscles inwards towards the arm-pit, and slightly upwards, so producing some degree of shortening, the upper fragment being tilted slightly outwards. The hand placed in the arm-pit will be able to detect the sharp edge of the lower piece. The roundness of the shoulder is maintained, but the finger passed over the shoulder comes down the arm only a little way before it reaches a break or hollow. There is pain and loss of function, and the man *keeps his arm close to his side.* When the lower fragment has been pulled down, the two ends will come into contact, and grating will be felt. Unnatural mobility also exists, but this is not so easily proved, because the person keeps the muscles strained to prevent movement.

This fracture is often confounded with dislocation at the shoulder; and it is of extreme importance to distinguish them, since the force required to reduce a dislocation might, if practised on a fracture, lead to very serious results. The following table shows the differences:—

Fracture.	*Dislocation.*
The roundness of the shoulder is maintained, the hollow being *a little way down the arm.*	The roundness of the shoulder is lost, the hollow being *immediately beneath* the point of the shoulder
There is a foreign body in the arm-pit, which is found to present a sharp ragged edge.	The body in the arm-pit has a round globular head and no sharp edge.
Increased power of movement.	Unnatural fixture, the arm cannot be freely moved.
The arm can be easily pulled down, and then crepitation (grating) is developed.	It is very difficult to pull down the arm, and there is no crepitation.
After reduction, on removing the reducing force the deformity returns.	After reduction, on removing the reducing force the limb remains replaced.
Arm shortened.	Arm rather lengthened.
Arm is held close to the side.	Elbow sticks out a little from the side, and cannot be brought close.
Usually produced by a fall on shoulder, the arm being at the time close to the side.	Usually produced by a fall, the arms being outstretched.

In children this fracture sometimes takes the form of separation of the epiphyses—the ends of the bone which have not yet become united to the shaft. It is very necessary to restore the proper position of the parts, otherwise development of the arm will cease. It occurs in children under ten only. Its signs are the same as those already described.

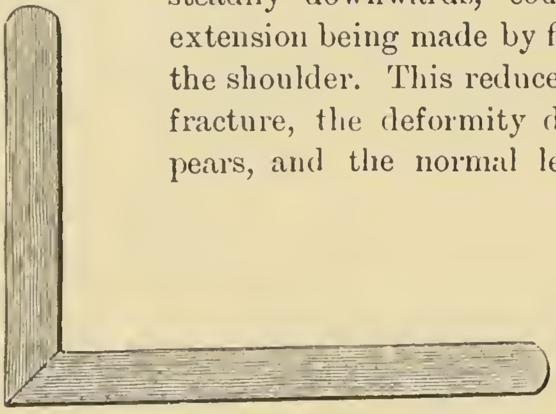


Fig. 36.—Right-angled Splint.

Treatment.—Bend the elbow, fold the arm across the chest, so that the thumb is directed upwards. Grasp the elbow and pull gently and steadily downwards, counter-extension being made by fixing the shoulder. This reduces the fracture, the deformity disappears, and the normal length of the limb is restored. To retain the limb in position two splints are necessary, one, long and right-angled or L-shaped (Fig. 36), so as to fit the position of the forearm across the chest, being placed on the inside, the other, a short moulded splint, being applied over the shoulder and seat of fracture. The inside splint is made of wood, and should be long enough to reach up into the arm-pit. To prevent pressure on the blood-vessels in the arm-pit, the top of the splint ought to be scooped out. One limb should extend down to the elbow, from which point the other limb comes off at an angle to pass along the forearm and hand. Before applying this splint, the hand and forearm should be bandaged. The splint is next to be carefully padded with cotton-wool, especially at places like the elbow where there are prominences of bone, and held in position, till the other splint is ready, by a few turns of a roller bandage. The outer short splint is made of gutta-percha, pasteboard, or other pliable substance. It is well softened in hot water, and is then placed, also padded, over the seat of fracture, to prevent the tilting outwards of the upper fragment. It should be long enough to project over the shoulder, round which it is to be moulded, and should pass downwards past the fracture to about the middle of the arm. This is immediately secured by one or two straps which bind both inner and outer splints. A roller bandage is then applied from the hand right up to the shoulder in the manner described under BANDAGES; and the forearm is then supported by a sling. It adds greatly to the comfort of the patient if, before the bandages and splints are applied, the arm is washed with soap and water, carefully dried, and then dusted with dusting powder. After not less than three weeks and not more than five, the splints should be removed in order to permit movement of the elbow and shoulder joints to prevent stiffening. The movement is not to be effected by the patient himself, for that would set muscles in action, and that is not desired; but some person must work the joints for a few minutes several times a day. To permit of this, and at the same time support the limb, small gutta-percha splints should be applied over the seat of fracture inside and out. After five or six weeks the patient may be permitted to swing his arm gently backwards and forwards, and gradually to bring it into use. In spite of the utmost care some permanent deformity is not unlikely to occur. The arrangements for this fracture are similar to those shown in Fig. 37, with this exception, that the outer splint should in this case be moulded round the top of the shoulder.

Fracture of the Shaft of the Arm-bone usually occurs below the middle of the bone. Falls on the hand or elbow are frequent causes. The fracture may be across or aslant, and presents all the usual signs of fracture, unnatural mobility, deformity, loss of function, and crepitation when the ends are brought into contact with one another. The displacement is effected by muscular action drawing the lower fragment to the inner side. Riding is also present, and shortening.

The **Treatment** (Fig. 37) is practically the same as that for fractures of the upper end.

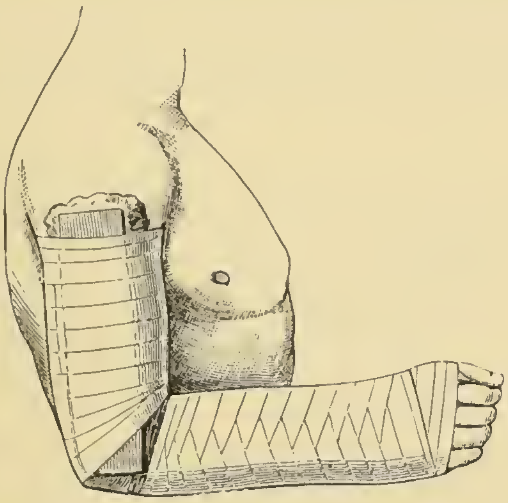


Fig. 37.—Arrangement for Fracture of Upper Arm.

The outer splint, however, need not go over the shoulder, but where the break is in the neighbourhood of the lower end it may be moulded round the elbow.

Fractures of the Lower End of the Arm-bone.—There are various kinds of fracture in this region. In one form there is a break across just above the joint; in another the fracture extends into the joint, the break extending both across the bone and running down the middle into the joint, so as to separate the processes, or condyles, that project on each side, from one another; while in a third form the epiphysis—the end not yet united to the shaft—is separated from the rest of the bone. A fall upon the elbow will readily produce this fracture.

Signs.—Deformity—the bones of the forearm, with the lower fragment, are, by muscles at the back of the arm, pulled upwards behind the upper fragment which projects in front, the two fragments riding on one another. The size of the joint from behind forwards is thus greatly increased and changed in shape, as may be seen by comparison with the arm of the other side. The projection in front is found to have a ragged edge, and the measurement from the top of the shoulder to the end of the arm-bone is less on the injured than on the sound side. On the other hand, the measurement from the knuckle of the middle finger to the end of the lump behind the upper arm is greater than the measurement of the forearm bones on the sound side, because to the forearm bones is added the length of the lower fragment retained in their grasp. Let an assistant hold the upper arm, let the operator place his knee in the elbow, grasp the wrist and pull the forearm round his knee. This easily reduces the fracture, and when it is reduced grating can be felt. As soon as the wrist is let go, the deformity returns. This is a fracture liable to be mistaken for dislocation at the elbow-joint. The differences are shown in the following table:—

Fracture.	*Dislocation.*
Kind of fall—fall on elbow.	Kind of fall—fall on hand, arm being bent
Projection behind of great mass, consisting of olecranon process of ulna grasping condyles of arm-bone.	Projection behind—olecranon alone.
Projection in front—small, broken end of shaft, not pushed deep down into elbow.	Projection in front—articulating end of humerus—condyles—pushed far down.
Motion increased.	Motion diminished.
Crepitation (grating) present on extension.	Crepitation absent.
Length of upper arm shortened.	Length of upper arm natural.
Length of forearm increased.	Length of forearm normal.
Reduction easy and not permanent.	Reduction difficult, but permanent.

Treatment for this fracture is also similar to that described under fractures of upper end of humerus, the outer splint being here moulded round the elbow-joint behind. The prominences of the joint should be carefully padded. The passive movement of the joint should be begun in about three weeks.

Splitting of the Condyles (p. 62) may be easily recognized by causing the elbow to be bent and stuck out behind. Then stand behind the patient and place one thumb on the projection of the humerus on one side, and the other thumb on the condyle of the other side, and press. If the condyles move on one another, splitting has occurred. The treatment is as above; or the joint may be entirely surrounded by a mould.

Fractures of the Forearm occur at the upper end, or at the shaft of radius or ulna (p. 62), or of both together, and at the lower end.

Fracture of the Olecranon (p. 62).—This is the fracture that occurs at the upper end, the olecranon being the process of the ulna that grasps the arm-bone behind, and forms the point of the elbow or "funny-bone." It is usually due to a fall on the elbow.

Signs.—It is easily distinguished. The chief muscle of the back of the arm—the triceps—is attached at its lower end to this process, and consequently when the connection between the ulna and the olecranon is severed the triceps has nothing to oppose it and pulls the point of the elbow up on the back of the upper arm. The point of the elbow is, therefore, gone, and a hollow is in its place. The person can *bend* the arm, but has great pain and inability to *straighten* it. The olecranon can be felt up in its unusual position and can be pushed down.

Treatment is a matter of some difficulty, because of the impossibility of overcoming the action of the muscle and keeping the process down in position; secondly, because union is by ligament and not by bone. The only way would be to keep the arm quite straight by a splint; but this is exceedingly irksome. The patient must make up his mind to get only a moderately satisfactory result, which will leave his arm not so powerful as before. The simplest method of treatment is to fix the arm at an open angle, to mould a splint for the back of the elbow, cutting in it a hole to admit the process, the edges of the hole being carefully rounded. Put this splint on, keeping the olecranon down in position as well as possible by means of the hole, and fix with a starch bandage (see BANDAGES) from the fingers up to the elbow.

Fracture of both Bones of Forearm at the centre of the shafts happens by direct violence. It is easily recognized, all the signs of fracture being easily made out. The bones are displaced towards the middle line of the arm, that is, they approach one another.

When only one bone is broken, the other one acts as a splint and prevents displacement. The way to detect the fracture in this case is to follow the outline of the bones by running the fingers firmly down from the elbow to the wrist. Examine one bone at a time. When the fingers come over the seat of fracture, the bone is felt to yield under the fingers, there is grating, and the patient feels pain.

Treatment.—Whether both bones be broken or only one the treatment is the same. Reduce the fracture by pulling on the wrist while an assistant keeps the upper fragment fixed. Then apply both outside and inside splints as broad as the arm, made of wood, or pasteboard, or similar material, and padded with cotton-wool. The splints should fix the wrist joint, but leave the elbow joint free. When the splints are being applied the hand should be held so that the thumb points directly upwards. Care ought to be taken that when the arm is bent the inside splint does not press hard up into the elbow, as it might compress blood-vessels and do harm. The splints should be secured by three straps, and then by a roller bandage from the points of the fingers up to the elbow (Fig. 38). The risk is that union may take place, not only between the ends of each bone, but also between the bones themselves, so that turning the palm of the hand upwards or downwards is afterwards prevented. To avoid this a pad or ridge of cotton-wool is recommended to be placed down the length of the arm, under the inside splint, to keep the two bones apart. There is danger of pressing too much on the blood-vessels by this, and it is, therefore, better to omit it. After bandaging put the arm in a sling. *No bandaging is here required previous to the application of the splint.* For this fracture splints are readily furnished out of bandboxes and similar material, the thin wood torn from which is cut to the size and shape required, and then steeped in hot water till it can be moulded, several layers thick, to the limb.

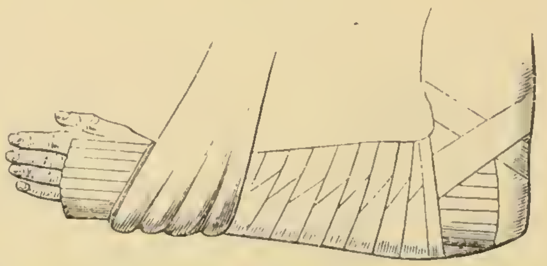


Fig. 38.—Application of Splints, &c., for Fractures of Forearm.

Fracture of both Bones close to the Wrist Joint may, from the nature of the deformity, be mistaken for dislocation at the wrist joint, though it must be noticed *that simple dislocation of the wrist joint is extremely rare.* In fracture the wrist bones with the lower fragments of the radius and ulna are shot up either in front of or behind the upper fragments, while in dislocation the wrist bones alone are carried up in front of or behind the forearm. The landmarks are the projecting processes—styloid processes—of the radius and ulna, on the outer and inner side. In fracture these are seen standing out from the sides, and bone can be detected beyond them, the wrist bones being still embraced by them. Next measure the forearm bones from the point of the elbow downwards to the projecting ends, and compare with the measurements of the opposite side. In fracture the measurement is less than the usual. Measure also from the knuckle of the middle finger to the upper end of the lower fragment. In fracture it is greater than the ordinary measurement from the same point to the lower end of the forearm bones. The other signs of increased movement, grating, &c., are present in fracture.

The **Treatment** is the same as that already described for fractures of the shaft, viz. two straight splints.

Fracture of the Lower End of the Radius (p. 62)—Colles' Fracture.—This is a fracture of very common occurrence. About one-third of the total number of fractures occurring in the body is of this kind. It is specially frequent in old people, and is oftenest caused in them by slipping on the street and falling on the hand, palm downwards, which has been put out to save them. It is a fracture of the radius, which is on the outer or thumb side of the forearm, and occurs about an inch above the wrist joint. It is called Colles' fracture, because it was first described by Dr. Colles of Dublin in 1814. It deserves special notice, not only because of its frequency, but also because of its liability to be mistaken for dislocation of the wrist.

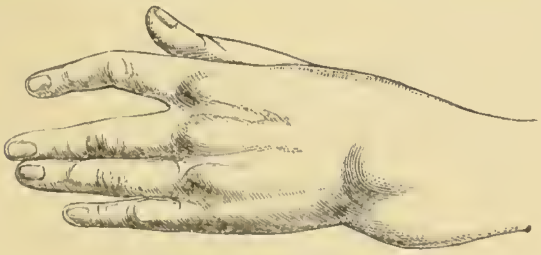


Fig. 39.—Colles' Fracture.

Signs.—The deformity is very peculiar (Fig. 39). The radius being broken, the support on the thumb side is removed and the forearm muscles so act on the hand as to pull it down to that side. As a result of this the skin is stretched on the inner side, and the projection—styloid process—of the bone on the inside of the wrist joint is very prominent, the stretching of the skin over it causing the patient to complain of pain there. This must not cause the attention to be diverted from the real place of the injury, which is on the outside. The lower fragment rides obliquely on the upper and produces a lump on the back of the forearm, and this again causes a sudden hollow in front between the hand and forearm. The patient cannot turn his wrist to lay the hand either palm downward or upwards. When the displacement has been reduced crepitation can be made out. The ulna is of usual length, but measurement shows the radius to be shortened.

Treatment.—To reduce the fracture support the forearm below the place of fracture with one hand; with the other grasp the hand of the patient as is done in "shaking hands," and pull the hand from the position of being drawn towards the radial or thumb side towards the ulnar or inside. A considerable force is frequently necessary to do this. The hand is pulled down towards the supporting hand of the operator, which acts as a fulcrum for the movement. As soon as the fracture has been reduced the deformity disappears. The best splint for retaining the bone in its proper position is the "pistol splint," so called from its appearance. It has a long straight part which should reach from the elbow to the wrist, and as broad as the broadest part of the forearm; it has also a part called the handle (*a*, Fig. 40), which should be as long as the distance between the wrist and tips of the fingers, and is directed downwards, forming an angle with the long portion equal to half a right angle. It is usually made of wood. To apply it, bandage the fingers and hand, pad the splint with cotton-wool, and then with a roller bandage fix the *handle of the splint to the back of the hand*, that is, *on the outside*, the hand being held thumb side upwards. When it has been fastened on so, the long portion of the splint is out of line with the forearm, projecting below it. Bring the long portion up to the line of the forearm, applying it close to the back of the arm. By this movement the handle is made to carry the hand downwards towards the ulnar side, aiding in the setting of the fracture, and retaining the ends of the bone in position. Another splint is then placed inside. It should be moulded out of pasteboard, gutta-percha, or other mouldable material, and should reach from the elbow

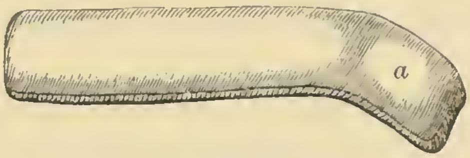


Fig. 40.—Pistol Splint.

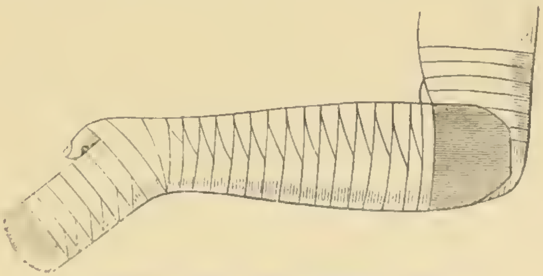


Fig. 41.—The Pistol Splint applied.

to the wrist only. Fix the whole by means of a bandage from the fingers to the elbow. (See Fig. 41.)

The trouble from the wrist joint is very great, owing to the great risk of stiffness resulting. The fracture will mend in a few weeks if properly put up; but it may be months before the wrist regains its function, if it ever thoroughly does so. Therefore in about three weeks in a young, and four in an old, patient, the wrist and joints of the fingers should be moved. Rubbing with liniments will also help to restore the function.

Fractures of the Bones of the Wrist (*Carpus*) may occur from direct violence, such as the passing of a wheel over the hand, but the deformity is not marked owing to the smallness of the bones and their numerous connections. There will be pain, swelling, and on handling the fingers may detect grating (crepitation).

Treatment.—Keep the wrist at rest by binding on the palm side a splint well padded. With the splint on the palm side, cold lotions, hot cloths, &c., may be applied on the back of the hand to keep down inflammation.

Fractures of the Bones of the Palm of the Hand (*Metacarpus*) are not unfrequently due to striking a blow with the closed fist.

The **Signs** are movement of the fragments and grating. Displacement is not so common here, but it may occur, the head of the bone sinking down towards the palm, and a projection being formed on the back of the hand.

The **Treatment** recommended by Sir Astley Cooper consists in causing the patient to grasp a large ball and then binding a roller bandage round the whole.

Fractures of the Bones of the Fingers (*Phalanges*).—These bones are often broken, usually with a wound or severe bruising. Sometimes the wounding is so severe that amputation is necessary. Every effort should be made to save a finger; and special pains ought to be taken with the thumb and forefinger.

Treatment.—Apply a thin wooden splint, lightly padded with wool, to the front of the broken finger, and secure with a narrow bandage. In about three weeks begin to move the joints to avoid stiffness of joints becoming permanent. If serious wounds exist the dressings will require to be renewed every two or three days. This should be done, if possible, without moving the splint. A moulded splint of gutta-percha or pasteboard is very comfortable.

FRACTURES OF THE SPINE.

The spinal column may be broken by indirect or direct violence. A heavy weight, such as a sack of flour, falling on a man's neck and shoulders may break the back some distance down. Again, a man has been known to be sitting on the branch of a tree when it broke and allowed him to fall to the ground in the sitting posture, fracture of the spine high up resulting. These are cases of indirect violence. Direct violence has many instances, a very common one being that of a miner whose back is broken by the fall of a mass of coal or earth as he lay, or was crawling along, face downwards. The break is generally transversely through the bodies and arches of the vertebræ. The accident may be a simple one or very grave. Spinous processes may be broken off merely, or vertebræ twisted round or otherwise displaced, with nothing further of any consequence, recovery taking place with some deformity but nothing worse.

In the majority of cases, however, the spinal cord is seriously injured, and the symptoms vary according to the degree and position of the injury.

Signs.—At first the person suffers from severe nervous shock, which may produce collapse, shown by pallor, coldness, feeble pulse, vomiting. There may be unconsciousness. When the shock passes off, pain is complained of at the seat of injury, especially on movement. There is swelling over the painful part, and irregular projections and depressions can be felt. But the important signs depend on the site of the injury.

(1) *When the injury is below the dorsal vertebræ* (p. 60), in the lumbar region, the legs and lower parts of the trunk are motionless and insensible. At first there will be great costiveness; and afterwards the stools will pass without the patient's will or knowledge. Owing to loss of power over the bladder the urine will be *retained*, requiring to be regularly withdrawn by means of an instrument. At a later period, if the urine is not regularly withdrawn, the water constantly dribbles away because of over-distension of the bladder. In a few days the urine will become offensive, smelling strongly of ammonia.

The person may live two or three weeks, or even a month.

(2) *If the fracture be lower down in the back than the second lumbar vertebra* (p. 60) power and sensation may not be lost, and recovery may be

expected to take place. This is because the spinal cord ends at the level of the second lumbar vertebra, and only appendages of it are continued further down the spinal canal.

(3) *If the fracture be higher up*, in the dorsal region, besides the symptoms mentioned under (1), breathing will be imperfect, and may be further impeded by attendant fracture of the ribs. Death is likely to result in about 5 or 6, or at most 10 or 15 days.

(4) *When the injury is still higher*, at the lower part of the neck, palsy of the arms is added, and the breathing is still more laboured. The patient cannot survive beyond a day or two.

(5) *If the injury be above the fourth vertebra of the neck* (p. 60) death will be instantaneous, because respiration is impossible.

When, as in injury below the dorsal vertebræ, the sufferer has survived for several days, or a week or two, there is great trouble owing to the involuntary passing of stools, the difficulty of keeping him clean, and the retaining of the urine. Bed-sores are a continual source of annoyance. They form most commonly over the prominent parts of the hip-bones and over the projecting process—trochanter—on the outer side of the thigh-bone. They begin to show themselves about the fourth, or even as early as the second, day. Their formation may be detected by the white, sodden appearance of the skin, which afterwards becomes brown, then black in the centre, after which the skin comes away in shreds. The sores form with great rapidity and sap the patient's strength.

Treatment.—First of all great care must be taken to guard against moving the spine while the patient is being carried home, undressed, and put to bed. He ought to be carried home on a stretcher of some kind, and kept from rolling about on the stretcher by bundles of clothing, &c. The clothes should be *cut off* to avoid movement; and the person ought to be laid flat on his back on an appropriate bed. The best bed for the purpose would be a water-bed. If a water-bed is not to be obtained then a bed with a bottom of boards, and one or two firm but elastic hair-mattresses is best. Bed-pans and other similar conveniences ought to be at hand, so that moving the patient is not necessary. Mackintosh cloth, covered with a sheet, ought to be under the the patient's hips. Water-pillows, feather-pillows, or pillows of other kinds, covered with oil-silk, are also necessary for equalizing the pressure on different parts of the body, to prevent, as far as possible, the formation of bed-sores. The urine must be drawn off by a catheter (see CATHETER) twice in twenty-four hours. In fact, as soon as the patient has been got to bed the catheter ought to be passed. The bowels may require to be moved by injection. To prevent bed-sores to the utmost extent cleanliness and dryness are absolutely necessary, and avoiding pressure by the use of pillows. When the sores have formed they should be cleaned with carbolic acid lotion (1 of acid to 60 of water). This lotion should also be applied to the sore by cotton-wool, which ought to be covered with gutta-percha cloth, and retained by straps of adhesive plaster. As to diet, easily digested food is necessary, milk, beef-tea, and similar fluid nourishment. It is to be remembered that exhaustion is often extreme, and requires guarding against. Indigestion is liable to afflict the sufferer. This is to be relieved by acid tonics (see APPENDIX OF PRESCRIPTIONS).

FRACTURES OF THE RIBS AND BREAST-BONE.

Fracture of the Ribs.—The ribs may be broken directly by a blow, which is apt to drive the fragments inwards to the injury of the lungs. Pressure on the body, as, for instance, that caused by a man being caught and crushed, say between two barrels or between a cart and a wall, is liable to produce fracture round at the back where the rib begins to curve forwards. In such a case there is great risk of fracture on both sides—a very serious accident. It is of importance to learn how the accident occurred in order to learn whether there is likely to be any wounding of the organs of the chest by the fragments. Fractured ribs added to chronic bronchitis or heart-disease are a very dangerous complication. Coughing may be an indirect cause of broken ribs in old people.

Signs.—The person has short, shallow breathing. There is sharp, stabbing pain, increased by movement and rendering coughing or deep inspiration extremely distressing. The person is able to put his finger on the exact spot where the pain is. The pain does not move about from place to place, but is fixed. If the patient complains not of pain *at a spot*, but of pain all over the chest, the chances are against fracture. If the person indicates the seat of pain, with two fingers trace along the outline of the rib, pressing firmly. When the place of fracture is reached the fingers will detect movement and grating, and the pain will be greatly increased by the pressure. If the person be very stout, and especially if the fracture be near the spine, these signs may not be made out. Nevertheless, if, after injury, there is pain complained of at a particular spot, on breathing, it is to be treated as fracture.

Treatment consists in giving rest to the affected part and preventing movement of the fragment. This is often done by bandaging the whole chest, but such treatment very often too seriously impedes respiration. A better way is to take strips of adhesive plaster long enough to reach from the middle of the back to a little way beyond the breast-bone. Make the patient lean to the uninjured side, and then, beginning behind, apply the plaster, carrying the strips from the spinal column forwards and slightly upwards to the breast-bone. The strips should be so placed in reference to one another that one strip overlaps the strip immediately below. The strips are to be applied in this way till the whole of the injured side is covered by a sort of cuirass of plaster (see Fig. 42).

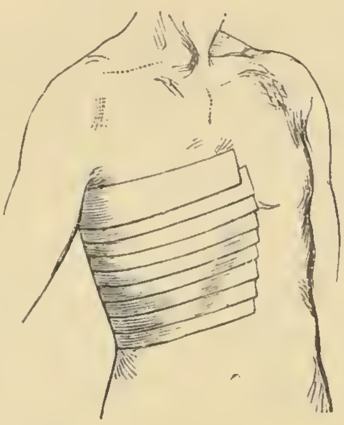


Fig. 42.—Mode of applying Plaster for Fractured Ribs.

For the first twenty-four hours after the accident the person should be propped up in bed in the sitting posture to relieve the breathlessness and feeling of suffocation. If the distress and pain are very great opiates may be necessary, and sometimes, in very exaggerated cases of this kind, bleeding is called for; but recourse should not be had to such remedies without the advice of a surgeon. In the case of an adult ten to twenty grains of chloral hydrate, to relieve pain and induce sleep, is the utmost that ought to be given by inexperienced persons.

Fracture of the Breast-bone (*Sternum*).—The signs of this fracture are practically the same as those of fractured ribs, and the treatment is also similar.

FRACTURES OF THE BONES OF THE LOWER EXTREMITY.

Fractures of the Hip-Bones (*Pelvis*) can be produced only by very great violence, and there is, therefore, great probability that other serious injuries will attend its occurrence. The cavity of the pelvis, as has been already explained (see page 63), contains and protects most important organs, which the great violence necessary to fracture the pelvic walls will be very likely to injure. The usual cases of the accident are of miners, upon whom a mass of coal has fallen. By pressing with one hand on either side of the hip grating may be produced. The person will, of course, be unable to sit or stand.

Treatment.—Keep the patient absolutely at rest in bed on a firm mattress or water-bed. A broad belt passed round the hip and firmly fastened will afford great relief. Then it may be necessary to withdraw the urine by means of an instrument, as the bladder may be paralysed. The person ought to be kept clean and dry, and the pressure on the hips relieved as much as possible by pillows, &c., in order to prevent the formation of bed-sores.

Fractures of the Thigh (*Femur*).—Fig. 43 shows a diagram of the femur, in which 1 marks the head of the bone, below which is the neck which unites the head and shaft; 2 and 3 are the prominences called great (2) and small (3) trochanters, of which the great trochanter is on the outside, and can be felt under the skin; A indicates the shaft; and at the lower end are seen the projections or condyles just above the surface for union with the bones of the leg. When the bone is in position in its socket, it is secured there by ligaments which completely surround the head, and form a capsule attached right round the neck of the bone. Now a fracture of the neck of the bone may occur either within the capsule, in which case it is called intracapsular, or without the capsule, when it is called extracapsular. In both cases the result is to separate the head from the shaft of the bone; and the signs are practically the same in both.

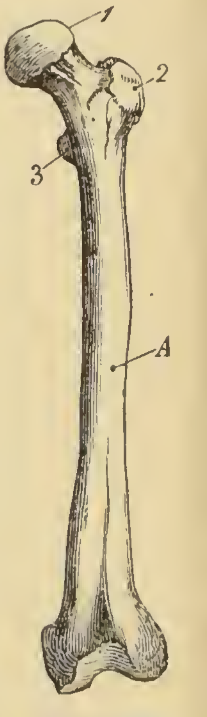


Fig. 43.—The Thigh-bone.

Fracture of the Neck of the Thigh-bone occurs usually in old people, and specially in old women. Its frequent occurrence in the aged is determined by changes occurring in the bone by which it is weakened and its resistance diminished. Wasting occurs, causing the neck of the bone to shorten, and the head to sink down towards the shaft. The wasting process is accompanied by an excessive amount of spongy bone substance and a diminished quantity of dense bone, the spaces in the bony tissue being also larger and filled with oil. The bone is consequently much less strong and less liable to bear a force suddenly exerted. Any sudden strain thrown upon it is, therefore, liable to cause it to snap through the neck. It is just owing to sudden rather than severe strains that the bone most frequently gives way. A trip on a carpet producing a stumble, not even a fall, missing a step, &c., have been known to produce it, while it is frequently due to a fall on a curb-stone.

Signs.—The signs are: (1) Loss of power in the limb; (2) Deformity; (3) Grating—crepitation; (4) Swelling and pain; and (5) Unnatural power of motion.

(1.) The loss of power is immediate, so that the person cannot rise; or if he succeeds in rising, it is only to fall again.

(2.) The deformity is characteristic. It consists in (*a*) a shortening, and (*b*) a turning *outwards*, of the limb (see Fig. 44). The shortening, which usually amounts to between 1 and 2 inches is due to the pulling upwards of the lower fragment by the muscles attached to the great trochanter; and the turning outwards is caused by the weight of the foot. At the same time there is a greater fulness than usual of the groin, an unnatural prominence of the groin, the result of the new position of the lower fragment and of the projection of the broken neck of the thigh-bone. The deformity may not arise immediately on receipt of the accident. The fall may have caused a temporary paralysis of the muscles, and accordingly the displacement cannot be effected till they have recovered. It may be that the ends of the broken bone have become locked, so as to prevent immediate displacement. The displacement may not occur for even a day or two, but suddenly some movement will release the locked fragments, and the deformity appears. It may also come on slowly, as the muscles recover from their paralysed condition.

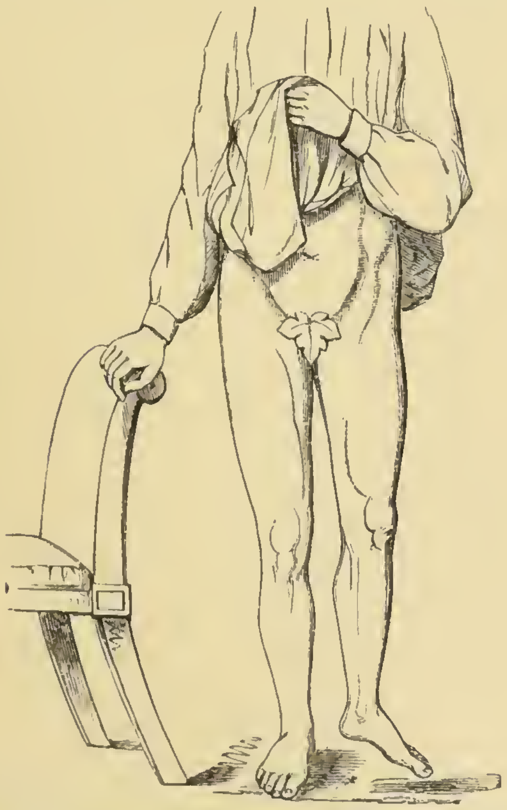


Fig. 44.—Fracture of the Neck of the Thigh-bone, showing shortening and turning outwards of the Leg and Foot.

(3.) The grating or crepitation is produced by pulling on the limb till it comes down to its normal condition, when the two ends of the bone can be brought together. To effect this an assistant should place one hand over the back of the foot and one hand under the heel, and pull slowly and steadily downwards. The person operating should fix the hips with both hands. By applying extension and counter-extension in this way the fracture is easily reduced, and then crepitation is developed by turning the foot up into its proper position. If the limb be now let go the deformity returns at once.

Care must be taken not to mistake this fracture for dislocation at the hip-joint, or for chronic rheumatic inflammation of the joint. In dislocation of the hip there is generally shortening, *but, instead of the foot being turned out, it is, as a rule, turned in.* In a certain kind of dislocation, however, it is turned out, though in this case the limb is lengthened instead of shortened. Then in dislocation there is no crepitation, and the reduction is extremely difficult, requiring considerable force and manipulative skill; while in fracture the reduction is easy. Again, in dislocation the bone, when returned to its socket, remains there, in fracture the deformity returns as soon as the extending force is removed. Lastly, in dislocation there is unnatural fixture of the limb, in fracture, unnatural capacity for movement.

A person afflicted with chronic rheumatic inflammation of the hip-joint may, after a fall, present features resembling fracture, namely, shortening and turning outwards of the limb. Great pain and swelling will also be present, and there will be loss of power. It will be found, however, that crepitation cannot be produced, neither can the limb be restored to its usual length by extension. Time and rest, with the limb in the position described below, and the application of hot fomentations to the hip, will eventually solve the difficulty. The history of the case will often help to a true decision. If the person has, long before the accident, suffered from pain and stiffness in the hip-joint, increased by wet weather, it is likely to be the rheumatic affection, and not fracture. The doubt can be cleared away at once, however, by an examination of the patient under chloroform. Under any circumstances cases presenting so much difficulty should always be handed over to a qualified doctor's care.

It has been noted (p. 90) that this fracture is specially liable to occur in old women; and its danger arises from this cause. The shock often kills, but, besides, lying in bed for any considerable time readily brings on congestion of the lungs in old people, and exhaustion is apt to carry the patient off. Then, in old people, such fractures never unite by bone, union by ligament only resulting, and often union does not occur at all.

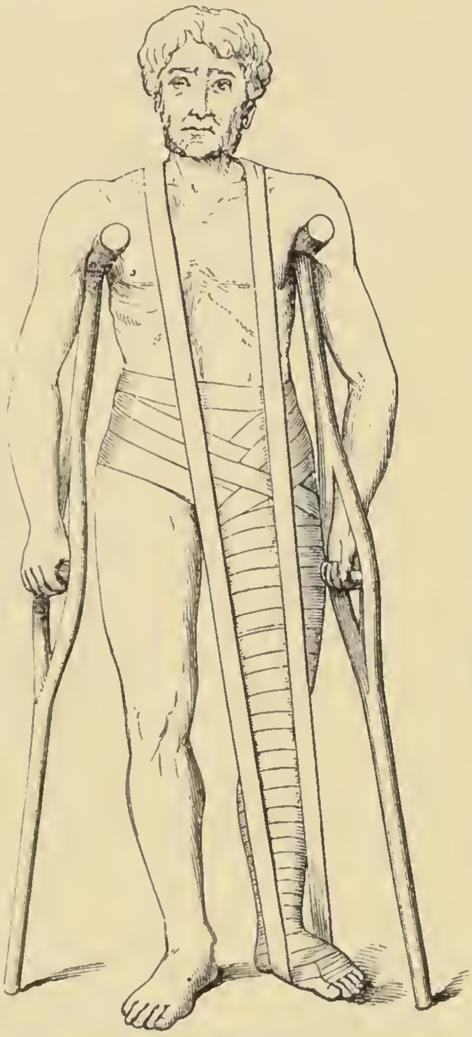


Fig. 45.—Mode of Support for Fractured Thigh in old persons.

The Treatment of this fracture, therefore, depends on whether the patient is old and feeble or young and healthy.

When the person is old he should be put on a firm mattress, with a heavy sand-bag on each side of the limb to keep it at rest and in position, and with a bag of sand or shot fastened to the foot, as described under Hip-joint Disease, and hanging over a pulley at the foot of the bed. This keeps the limb straight, and keeps up continuous extension. After a fortnight the person may get up and sit in a high chair, and may, after a little time, begin to move about with the aid of crutches, the limb being supported by a sling from the neck. (Fig. 45.)

Another method of treatment, valuable because of its aid in warding off congestion of the lungs, is by the doubly-inclined plane. Two boards are united by hinges so that they may either be stretched out flat or raised to form a double incline, the top of which is at the hinge. (Fig. 46.) The plane is fixed at the end near the body of the patient to a bed-piece, the sides of which are provided with notches, by means of which the lower end is fixed. The slope of the plane is regulated by the notch into which the lower end is placed. The apparatus is laid on a firm mattress, and is well cushioned, and the patient is so placed that the upper board reaches to the prominences of the hip-bones that form the seat. The leg should be carefully bandaged from the toes to the groin, and two splints made of pasteboard or gutta percha softened by heat are strapped to the thigh on the outer and inner sides from the groin to the knee. The limb is then laid over the double-inclined plane, raised to the angle most comfortable to the person, the hinge of the apparatus being directly under the knee. To the end of the lower board a foot-piece is attached to which the patient's foot is strapped, while holes are bored at intervals along the splint to admit of tapes passing through to secure the limb. A roller-bandage may be passed round both splint and limb. The action of the splint is aided by the patient being propped up slightly with pillows. The Macintyre splint is one made on this plan, with appropriate hinges and screws.

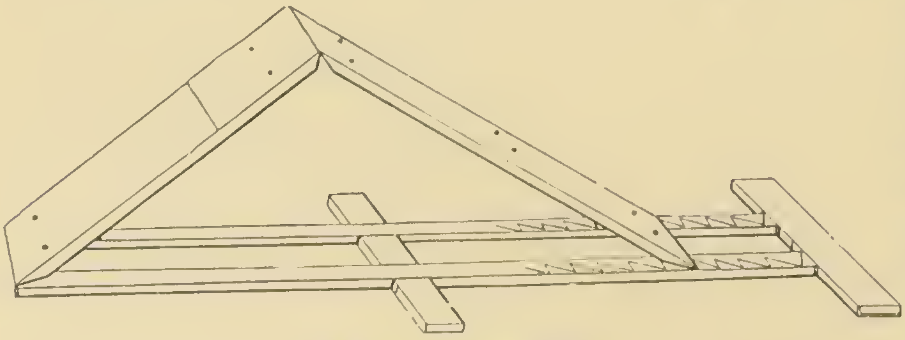


Fig. 46.—Double Inclined Plane.

When, however, the person is young and healthy, efforts ought always to be made to secure bony union. This is done by continuous *extension* and *counter-extension* (p. 79) practised by means of Liston's long splint. It is a deal board of slightly greater breadth than the limb for which it is used. It should be long enough to reach from below the arm-pit to 4 or 5 inches beyond the foot. Two holes are pierced at its upper end, and two deep notches are cut out at the lower end. (See Fig. 47.) The limb having been washed, carefully dried and dusted, a piece of broad roller bandage twice as long as the patient is taken, and the centre of it placed across the sole of the foot like a stirrup, the ends passing up the leg, one on each side. A roller bandage is to be then applied to the foot and leg (see Bandages) nearly up to the knee, fixing the first bandage on each side. When the knee has been reached the two ends of the side bandage ought to be *folded back down the sides* *of the leg*, so that the ends hang free beyond the foot, the roller being then carried back from the knee to fix the side bandage a second time. Thus a broad strip of bandage has been firmly secured to each side of the leg, the ends hanging beyond the foot. The splint is now to be padded. This is best done by taking a thick sheet and rolling it round and round the splint, a part being left free to encircle the limb and splint when the splint has been applied. The splint is now placed along the leg on the outside, the free part of the sheet being carried under the leg and left ready to be tied up when required. The two free ends of the bandage that has been secured to the leg are now to be taken and fastened tightly through the notches at the lower end of the splint, so that the foot is securely fixed to the lower end of the splint. The next thing required is a band for counter-extension, called the **perineal band**. A large handkerchief would suit, but the best thing is a special pad made of strong linen in the shape of a bag about one foot and a half long and about 1 inch wide. It should be stuffed with wool, and covered with oiled silk at the place where it comes in contact with the skin. It should have strong linen ends of sufficient length for the purpose to be explained. The pad is placed between the legs so that the centre of it catches on the portion of the hip-bone between the legs. One end passes up over the buttocks behind, the other passes in front. The ends are then taken and one passed through one hole in the upper end of the splint, and the other through the other hole in the same end. All is now ready to be secured. Previous to tightening up the apparatus pad with wool any part not sufficiently protected by the splint-sheet. Now let an assistant take the foot (one hand over the back, one hand supporting the heel), grasping the lower end of the splint at the same time, and make steady extension till the deformity has disappeared and the limb is of the same length as its fellow, which ought to be brought alongside for comparison. At the same time the operator ought to be making counter-extension by steadily pulling the ends of the perineal band through the holes. When the limb has been pulled down sufficiently—and it is best to draw it down even a little farther than its natural length, say ½ to 1 inch more, to prevent shortening—it is secured by tying the ends of the perineal band tightly over the holes through which they pass. The splint-sheet is then brought up on the inside of the leg, folded over, and stitched or laced over the splint. A broad bandage should fasten the upper end of the splint to the body.

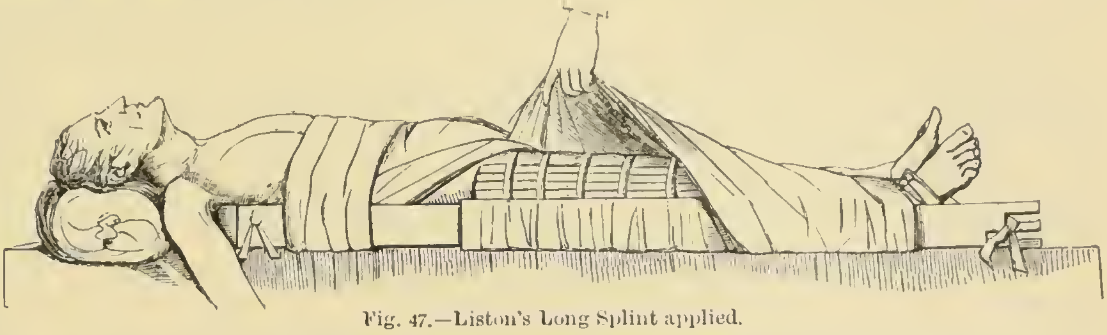


Fig. 47.—Liston's Long Splint applied.

Fig. 47 shows the splint applied, in which also short splints are represented as applied in the fracture next described.

It will take probably six weeks before the splint can be removed. During this period pains must be taken to support the patient's strength with nourishing, easily digested food, and to prevent bed-sores forming, especially in people advanced in years.

After the removal of the splint the limb should be put up in a starch or plaster of Paris bandage (see BANDAGES), and the patient may then be allowed to go about on crutches. Some support to the bone will be required for two or three months.

Fracture of the Shaft of the Thigh-bone is attended with marked symptoms.

Symptoms.—The deformity is caused by the lower fragment being pulled upwards behind, and generally a little to the inner side, of the upper. Occasionally the upper fragment projects forwards. There is loss of power, turning of the foot outwards, shortening of the limb, unnatural mobility, grating when the fracture is reduced, swelling, and pain.

The **Treatment** required is the same as that prescribed for fracture of the bone at the neck, the long splint, which is adapted specially for this kind of fracture. The directions given there should be carried out, with this addition, that directly over the seat of fracture short splints ought to be applied. They are shown applied in Fig. 47. They may be made of several layers of pasteboard or gutta-percha softened in hot water, and should extend a little way above and below the fractured place, being secured by straps of bandage. The long splint is put on outside of them.

After recovery some degree of permanent

shortening is to be expected. It will be many months before anything like natural movement is restored to the joints. To help this, friction, movement by the hands, &c., must be diligently employed.

Fracture of the Lower End of the Thigh-bone is very serious from its nearness to the knee-joint; and as it is frequently the result of direct violence the joint is liable to inflammation.

Signs.—The recognition of the nature of the accident is easy—mobility, grating, shortening, loss of function, swelling—all are present. The lower portion of the thigh is greatly disfigured, because the lower fragment is drawn up behind and to the inside of the upper one.

Treatment.—Put the limb up in the long splint, as directed for fractures of the upper end of the bone, and place short splints in front of and behind the joint, with a pad of wool in the hollow behind the joint. Sometimes this fails to keep the bones in position. In such a case the doubly-inclined plane must be used, as described under FRACTURE OF THE UPPER END OF THE THIGH-BONE (p. 92). A bag of ice or hot fomentations may be required to keep down inflammation of the joint.

Fractures of the Knee-pan (*Patella*).—The knee-pan may be broken across or in its length, or it may be broken to pieces—comminuted. It is frequently broken by muscular contraction. A person slips, or is in danger of falling from missing a step going down-stairs, and makes a sudden strong effort at recovery. The straight muscle in front of the thigh is suddenly contracted, and so the knee-pan to which it is attached snaps through. It may be caused by a blow or fall on the knee.

Signs.—After the sudden snap or the blow the person is unable to straighten his leg, and cannot support his weight on the affected limb. On examination the bone is found in pieces, and a finger may be inserted into the crack between the fragments.

From the difficulty of keeping the parts in apposition this bone unites by ligament only, and the amount of separation between the two fragments depends on the treatment. One to two months are required for satisfactory union.

The **Treatment** aims (1) at relaxing the muscles that would tend to drag apart the fragments, and (2) at keeping the parts in close apposition. This is effected partly by position and partly by mechanical means. (1) The patient is placed in a half-sitting position, and the injured limb is straightened and raised at the heel. (2) For maintaining the bones in apposition a variety of methods have been suggested. A straight, well-padded splint may be put on behind, having two hooks projecting backwards, one a little way above the joint, the other a little way below. The leg is bandaged to the splint from the toes upwards till the lower hook is reached. The bandage is caught on it, and then carried upwards and across the front of the leg above the upper fragment, curving downwards to reach the lower hook again. The same bandage is then caught round the upper hook, and carried downwards round the lower fragment, curving upwards thereafter, to be again fastened to the upper hook. Thus a figure-of-8 movement of the bandage is made, the result of which is to draw the fragments together. Or, the leg having been bandaged from the toes, a short strap of bandage may be placed on each side of the leg, at the knee-joint, secured by two handkerchiefs, one tied tightly above the joint, the other tied tightly below. The two handkerchiefs are then pulled together, and the fragments brought together by drawing on the ends of the side strap and tying them. Fig. 48 shows how this method may be applied. An American method is to fix a long strip of sticking-plaster, 2½ inches wide, in front of the limb from the upper portion of the thigh to the middle of the leg, leaving at the knee a free loop. A bandage is applied above and below the knee to fasten the strip. A small stick 6 or 8 inches in length is put through the loop over the knee, and the plaster twisted until the fragments are brought close.

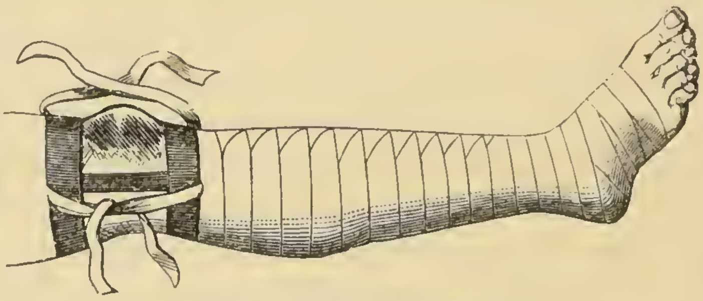


Fig. 48.—Arrangements for Fractured Knee-pan.

The apparatus should be kept applied for thirty-five to forty days, and afterwards the knee supported by a knee-cap. The knee will never be so strong and useful as before, and some lameness, greater or less according to the closeness of the union, is sure to result.

Fractures of the Leg (*Tibia and Fibula*) are very common, and may be caused by direct violence, but are often produced indirectly, as by jumping from a height. One bone may be broken alone, but fracture of both bones is more frequent. The special place is about the lower third of the tibia and higher up in the fibula.

Signs.—If one bone only has been broken there may be little displacement, the other bone acting as a splint. To detect the fracture pass the fingers down each bone from the knee to the ankle. When the broken part is reached the fingers sink down, the patient cries out, and grating is felt. The person is unable to support himself on the injured limb. There will be shortening and overlapping of the bones when both bones are broken, rarely when only one.

Treatment.—Bandage the leg and foot. Place straight well-padded splints, one on each side of the leg, an assistant meanwhile pulling gently but firmly with one hand over the back of the foot, and the other supporting the heel, to keep the bones in position; and bandage the splints and limb together. The splints can be easily made of pasteboard or light wood, such as can be obtained from a bandbox. They should pass up beyond the knee-joint and project beyond the foot.

Pott's Fracture of the Leg.—This is a fracture of the clasp-bone low down in the neighbourhood of the ankle-joint, associated with partial dislocation of the foot outwards. It is produced by jumping down on the side of the foot. The appearance of the foot is characteristic (see Fig. 49). That the outer bone is broken may be detected by passing the fingers firmly along it down to the joint.

Treatment.—This requires a splint with a foot-piece besides a straight splint. The foot and leg are first bandaged. A straight splint, padded, is then put on the outside of the limb. For the inside a splint is required that has a portion projecting upwards, and hollowed out so as to receive the side of the foot and great toe. This can be made on the spot out of some material capable of being cut to the shape required, and then softened and moulded. Bandage splints and limb together. Care must be taken that the foot is at right angles to the leg. It is to keep the foot in this position that the splint with foot-piece is used. *In all cases of fracture of the leg, the foot should be maintained in such a position that the great toe is in a line with the inner edge of the knee-pan.*

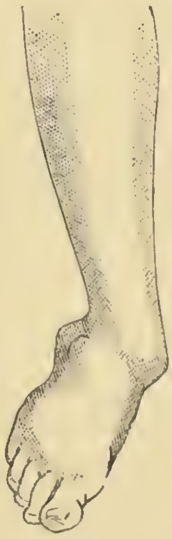


Fig. 49. — Pott's Fracture of the Leg.

In many cases of fracture in the neighbourhood of the ankle-joint there is great difficulty in keeping the fragments of bone in position. If they won't keep in place with the leg straight, then turn the person on his side and bend the limb. Use a straight splint, extending on the inside of the leg from 4 inches above the knee to 3 inches beyond the foot with two notches at the lower end (Fig. 50). Pad this with a sheet folded double opposite the ankle, or with a pillow made of cotton-wool to suit the splint, and 2 or 3 inches thicker at the lower than at the upper end. A bandage is to be then applied so that the foot is bent inwards over the thicker portion of the pad, which should rest against the internal malleolus, the process that projects inwards just above the ankle-joint. Fig. 51 shows the leg in the proper position; and Fig. 50 gives a side view of the same arrangement. The splints ought to be removed after four or five weeks, and movements of the joints practised to avoid stiffening. For several weeks longer support ought to be given to the limb by plaster or bandage or laced boot.

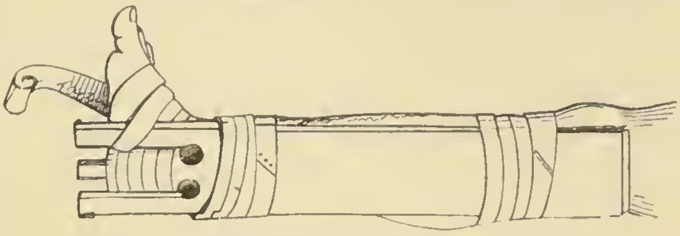


Fig. 50.—Splint for Fracture of the Leg: side view.

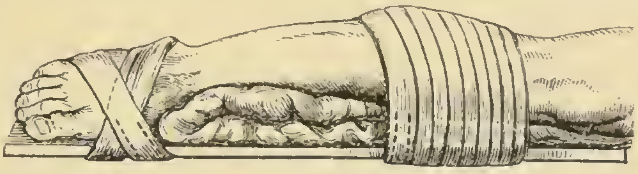


Fig. 51.—Arrangement for Fracture of the Leg.

Compound Fractures of the Leg are of frequent occurrence, because the thinness of the muscular covering easily permits the ragged ends of the bone to burst through the tissues. When the bones are projecting they are to be returned as carefully as possible, not by force but by manipulation. The wound is to be washed with a lotion made of one part carbolic acid and sixty parts of water. It is to be covered with a piece of lint soaked in this solution, the lint being kept moist by oiled silk laid over it. In putting up the leg a little window ought to be cut out of the bandages, through which the wound may be dressed. The permanent apparatus ought not to be put on till all serious bleeding has ceased or been stopped. See under ACCIDENTS.

Fractures of the Bones of the Foot are commonly caused by the foot being crushed by heavy weights. There is usually serious mischief, which may necessitate amputation. Sometimes the projecting process of bone that forms the prominence of the heel is broken off, and pulled upwards by the muscles attached to it. Its altered position can be readily perceived.

Treatment.—The foot should be placed at rest on a pillow, and ice or hot cloths used to subdue any threatened inflammation. The best position for relaxing the muscles at the back is with the knee bent and the foot extended as much as possible. This extension of the foot may be effected by a splint passing *down the front of the leg* and pressing on the back of the foot to keep it far down, and the heel consequently high up. Other splints of easily softened material can be moulded to suit the occasion.

It will probably be months before the proper use of the foot is restored. Till then crutches will be necessary.

INJURIES OF JOINTS.

DISLOCATION.

General Considerations.—A dislocation is the forcible separation of the surfaces of two or more bones forming a joint—the more or less complete displacement from one another of the articulating surfaces of bones.

Its **causes** are Predisposing and Exciting.

Predisposing Causes.—The muscles and tendons are very important agents in keeping the bones together. Anything which weakens or relaxes them will cause liability to dislocation, such as constitutional weakness and relaxation owing to previous disease, dropsy of the joint, for example.

The **Exciting Causes** are—(1) External violence and (2) Muscular contraction. (1) The violence may be applied directly, as when a person falls on the shoulder and displaces the humerus; or indirectly, as when the person falls, not on the shoulder, but on the hand, which has been stretched out to save the person. In the latter case the force acts on the shoulder-joint by means of the leverage supplied by the arm. (2) Muscular contraction during trials of strength, wrestling, or during fits, may cause displacement. The jaw is generally dislocated by muscular action.

Kinds.—Dislocations are *simple* when there is no further injury than the separation of the opposed surfaces of bone, and *compound* when a wound leads into the joint. They are *complete* when no parts of the articulating surfaces of the two bones remain in contact with one another, and *partial* when some portions of the opposed surfaces are in contact, but not the proper parts. Again, according to their period or cause of production, dislocations are said to be *congenital*, that is, born with the child, *pathological*, when the dislocation is due to disease, and *accidental* or *traumatic*, when force is the agent.

Results.—Besides the bones being forcibly removed from their natural position, a considerable amount of injury is done to the surrounding parts. The ligaments of the joint are torn; muscles are stretched and often torn also; nerves are frequently compressed, causing severe pain at the time of the accident and paralysis afterwards. Blood-vessels are seldom seriously hurt unless in complicated cases, though they too may be compressed and the circulation in the part interfered with. When the bones are restored to their proper position all these breaches are in time repaired; even paralysed nerves may regain their power. But when no reduction has taken place, and the bone has been left in its unusual position, it proceeds to accommodate itself to the new situation. By constantly playing and moving in the unusual place it gradually forms there a new joint. The bone on which it moves gets hollowed out to fit it, and even becomes lined with a substance like gristle. Bands of adhesion are formed to secure the bone, and a joint capsule by and by surrounds the joint, while the old cavity gets filled up with deposited matter. The result of this reparative process is that after the lapse of a certain time from the date of the accident it would be rash and dangerous to attempt to restore the bone to its old socket. It is not merely on account of the fibrous adhesions and capsules that have been formed, but because blood-vessels and nerves may be implicated in the changes that have occurred since the dislocation. Sometimes, especially in the case of small bones, bony union, instead of the formation of a new joint, takes place. At what time it becomes unsafe to reduce an old dislocation it is difficult to say. Sir Astley Cooper said that the thigh could not be reduced after eight weeks, and the arm after three months. But a shoulder displacement has been reduced more than a year after the injury, and without chloroform. In St. George's Hospital Reports two cases are related, one of reduction of dislocation of the shoulder on the one hundred and seventy-fifth day, and the other a reduction of dislocation of the wrist six years after the accident. The possibility or impossibility of reducing an old dislocation depends very much on the patient. If he is an old feeble man the changes that have been referred to are likely to occur slowly and imperfectly, and adhesions in the new unnatural position are probably correspondingly few and feeble; while if the person be young and vigorous, and especially if inflammation has occurred, the new connections are probably strong, and quickly developed.

Signs.—(1) *Deformity*, (2) *Sudden loss of function*—motion, (3) *Change of length* of the limb, (4) *Change in the relationship of processes*, (5) *Pain*, *swelling*, and *discoloration*.

(1) The *Deformity* is to be ascertained by comparison with the sound side of the body, and care must be taken that distortion, supposed to be the result of dislocation, is not swelling or due to previous injury or disease. The latter is to be learned from the patient himself. The distortion is the effect of the unnatural position of the limb, and generally consists of a prominence at one place and a hollow at another.

(2) *Loss of Function.*—The person cannot move the limb at the joint involved. Inability to move a joint is often present because great pain is produced by the effort, and therefore the patient keeps his muscles tense, so that movement cannot be effected. In dislocation, however, there is actual inability to move the part because the bones have lost their relations to one another, and the muscles cannot act upon the bones in the proper direction. Further, there is unnatural fixture of the bones even to a person, other than the patient, attempting to move them, and even after the patient has been chloroformed and the muscles relaxed.

(3) *Change of Length.*—In all dislocations with one exception the limb is shortened. The exception is the case of dislocation of the thigh-bone forward on the front of the hip—strictly speaking on the obturator foramen (see p. 63). In this case the limb is lengthened.

(4) *Change in the Relationship of Bony Processes* is one of the most reliable signs. For instance, in dislocation at the shoulder-joint, the head of the arm-bone loses its relation to the acromion process of the shoulder-blade, a hollow existing beneath the point of the shoulder where the head of the bone ought to be; in dislocation at the elbow-joint the olecranon process—point of the elbow—and the condyles or projecting processes on each side of the lower end of the arm-bone, are severed from their connection. Sometimes, owing to swelling, considerable difficulty is experienced in detecting this sign.

Signs that Distinguish between Fracture and Dislocation.—Distinctions have already been noted between dislocation and fracture at special places. The following general differences are to be noted:—

(1) Movement—in fracture the movement is increased, in dislocation diminished.

(2) Presence in fracture of crepitation or grating, when the ends of the broken bone are rubbed against one another. In dislocation there is no true crepitation. A slight crackling or rubbing may exist in dislocation, though it is not developed for a day or two after the accident.

(3) The bony processes have in dislocation lost their relationship; in fracture it is not so, the bony processes of the lower fragment being still in the grasp of the connected bone.

(4) In fracture the deformity is easily removed, but returns on extension being removed; in dislocation reduction is difficult but permanent, the bone returning to its own place usually with a snap.

It is frequently difficult even for experienced surgeons to determine whether the accident is of the nature of a fracture or a dislocation. When it is impossible to decide, the rule is to treat it as a fracture.

Treatment.—The object of treatment is to restore the bone to its natural position. The action of the muscles opposes this object, the tendons also, and sometimes the torn ligaments by being caught round the head of the bone. Not only does the natural tension of the muscles oppose the reduction, but the patient unavoidably increases the force. This difficulty can be overcome by chloroform. It can, however, be administered only by a medical man. There are other means at the disposal of those unqualified to give chloroform. A hot bath, for instance, relaxes the muscles. A simple method is to attempt reduction *before the person has recovered the shock of the accident*, while the muscles are still relaxed; or, if that period has passed, the same result may be partially obtained by suddenly, by a shout or quick exclamation, diverting the patient's attention. In order to draw the bone down from its new position to the place of its socket, **extension** is necessary. To effect this the upper bone containing the socket is fixed by an assistant, who, by this means, provides **counter-extension**. The displaced bone is then pulled continuously and steadily downwards, till it is brought into such a position that the muscles may set it. At the same time the hands, knee, or foot of the operator may act upon the bone so as to aid in its proper adjustment. This is called **coaptation.** The extension should be performed in the line of the opposing muscles. Extension may be performed by hand, or by various mechanical contrivances, especially pulleys, while the counter-extension may also be by hand, or by means of bandages passed round the body of the person and fixed to a staple in a wall. A more recent method of reduction is by manipulation. It is specially serviceable in dislocation at the hip-joint, in which great force is required to overcome the resistance of the muscles. In the method by manipulation no force is employed, but the limb is caused to execute certain movements by the hand alone by which the head of the bone is induced to slip back into the joint, the resistance of the muscles not being called forth by the movements. This will be described in discussing the treatment of special dislocations. After reduction the joint ought to be kept at rest for some time to permit of the healing of the torn ligaments, and to avoid the risk of inflammation. Should inflammation be feared, with perfect rest the use of warm fomentations may be conjoined. The application of cold cloths or cloths wrung out of iced water will often give even greater relief. After all danger of this kind has passed away the joint will remain weak for some time. This is to be gradually remedied by gentle movement, made at first by hand then by the muscles of the part, by the use of the hot and cold douche alternately, and by friction with some liniment—soap and opium liniment. Restoration of function by this means is attempted soon enough a fortnight after the accident. For a considerable time, even months, afterwards, the joint must never be placed in a position that would strain its ligaments, since a second dislocation would very readily follow a first.

Fracture is a very serious and dangerous complication of dislocation.

When a wound communicates with the joint from which the bone has been dislocated, inflammation of the joint is apt to ensue and to run a rapid course ending in complete disorganization, demanding amputation of the limb or cutting out of the joint—excision—to save the life of the patient.

DISLOCATION OF THE SPINE.

The displacement of one vertebra from its position on another is seldom effected without fracture, except in the region of the neck. In the neck dislocation may occur between the axis and the atlas (p. 61). It has been pointed out (see p. 61) that the odontoid process of the axis moves in a ring of the atlas, that immediately behind is the canal of the spinal column, occupied by the spinal cord, and that separation between the odontoid process of the axis and the cord is effected by a ligament passing across between the two. Besides this ligament there are others, one passing upwards from the top of the process to the base of the skull, and two passing sideways to the base of the skull at the margins of the large opening—foramen magnum—through which the spinal cord passes to join the brain. These all aid in retaining the odontoid peg in its place. Nevertheless these ligaments may be ruptured, and the axis torn from its connections with the atlas above it. The result is that the peg is crushed backward upon the spinal cord, destroying it, causing instant death, for it is in this neighbourhood that the principal nerve centres exist which control the breathing, &c. This is one of the occurrences, and the immediately fatal occurrence, in "broken neck" from a fall or hanging.

Dislocations may occur in other parts of the spinal column, though they are, as has been said, rare without a fracture. The results are less serious the further down the column the dislocation happens to be. What has been said about fracture of the spine applies equally here, and reference should be made to that fracture. The signs of the two accidents are very similar.

The **treatment** also must fulfil the same conditions. Careful manipulation may be employed if any displacement of bone is apparent, to see whether any setting is possible. The head and shoulders may be fixed while the legs are being very gently pulled downwards. It is doubtful, however, whether anyone but a surgeon ought to try this. In any case the utmost caution must be exercised. The injunctions given in discussing the treatment of fracture of the spine, namely, absolute rest, careful nursing, attention to the bowels, and in particular to the state of the bladder, and the regular use of the catheter, if required, avoidance of anything likely to encourage the formation of bed-sores, &c., all these must be constantly kept in view. In turning the patient, shoulder and hip should be turned at the same time, so that movement of the spine may be prevented.

DISLOCATION OF THE LOWER JAW.

The movements of the lower jaw in chewing, yawning, and laughing cause its articulating processes to move forwards in the socket of the joint, and it is by spasm of certain muscles during these movements that the bone may be jerked so far forwards as to be forced out of joint. Immediately in front of the socket is a small bony knob, which the bone slides over in the act of dislocation, and which bars the return of the bone to its socket. Fig. 52 represents this dislocation, * being opposite the socket, *r* being the articulating process of the lower jaw, and *k* the bony knob referred to. A blow on the chin, when the mouth is open, may also produce the dislocation, but it occurs most frequently in the act of yawning. It may be on one side only, or on both sides.

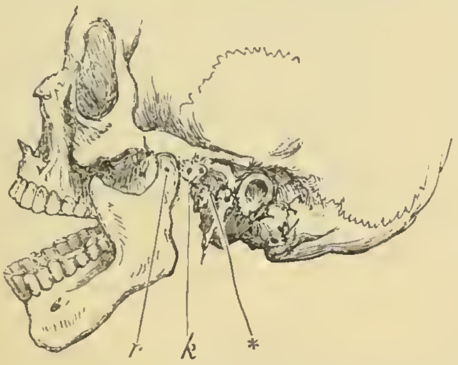


Fig. 52.—Dislocation of the Lower Jaw.

Signs.—When both sides are dislocated the mouth is fixed widely open; saliva dribbles from the mouth; the patient cannot speak nor swallow; and there is a hollow in front of the ear on each side, and above in front of this the prominence of the head of the bone. When the dislocation is on one side the chin is twisted towards the sound side. If the jaw is left alone, partial recovery takes place in course of time. The power of speech and of swallowing is gradually restored; the jaws come together to a considerable extent; and the saliva ceases to flow; but for a very long period great discomfort remains.

Treatment.—Let the operator stand in front of the patient and insert the thumb of each hand into the mouth, resting them on the teeth of the lower jaw. The thumbs must be well protected by lint or by a napkin wrapped round them. They should reach back to the last grinding tooth. The fingers are at the same time placed under the chin and base of the jaw. The patient's head being fixed against a wall or the back of a high chair, the operator presses the grinding teeth downwards with his thumbs, while raising the chin with his fingers. As soon as the bone becomes disengaged from its unnatural position the muscles pull it backwards into the joint. The return is effected suddenly, and the operator's thumbs are liable to be caught by the quick snapping closure of the mouth and seriously bruised, unless they have been properly protected. If the person is quick enough he may succeed in avoiding the snap by slipping his thumbs to the side between the gums and cheek. If this method of reduction fails greater power may be exerted by placing a piece of soft wood between the upper and lower grinding teeth on each side, the piece being thick enough to fill the space between them. The chin is then steadily pulled upwards, *but not forwards*. The pieces of wood act as a fulcrum for depressing the back teeth. A spoon or handle of a fork laid along the teeth would fulfil the same purpose.

After the reduction the chin ought to be confined for a time, a week or two, by a bandage, to prevent renewed dislocation; and the person ought always afterwards to guard against opening the mouth too widely, as this is a dislocation which, once effected, is easily reproduced.

Partial dislocation of the jaw may occur, especially in people of relaxed habit of body. The symptoms are not so marked, but the mouth is fixed, and cannot be shut. A smart push may be sufficient to return the bone, and the person must exercise care in opening the mouth.

DISLOCATION OF THE COLLAR-BONE
(*Clavicle*).

The collar-bone is united to the breast-bone by means of a joint, at which dislocation may be produced by a fall on the shoulder or by a blow. The collar-bone may be displaced forwards, when the projecting end of the bone is easily felt; or it may be backwards, when symptoms of difficulty of breathing or of swallowing may be caused by the backward pressure of the displaced bone. Curvature of the spine has been known to produce this form of the dislocation. The bone may also be forced upwards.

Treatment consists in replacing the bone by drawing the shoulder outwards and backwards, while an assistant presses the head of the bone into its place. Thereafter the treatment for fracture of the collar-bone is to be employed, a pad being placed over the end of the bone to retain it in its place. The bone very easily slips out again, even though the greatest care to prevent it be exercised.

DISLOCATION OF THE SHOULDER-BLADE (*Scapula*).

This has also been called a dislocation of the collar-bone, because it is the outer end of it that is forced out of position. A reference to Fig. 20 shows the connection between the outer end of the collar-bone and the projecting process of the shoulder-blade called the acromion process. In this form of dislocation the outer end of the clavicle is forced upwards on the process, that is to say, the process or point of the shoulder is under the end of the collar-bone. Rarely, the positions are reversed.

Signs.—The shoulder is depressed and carried towards the breast-bone, the movements at the joint being restrained. On tracing the collar-bone outwards with the fingers its abnormal position can be made out.

Treatment.—Replacement is effected by pressure on the displaced bone, while the shoulder is pulled backwards. After replacing the bone the treatment is the same as for fractured collar-bone, with the addition of a pad made of several layers of soft cotton cloth applied over the outer end of the collar-bone and secured by a bandage passing downwards round the elbow, the arm being bent across the chest and bandaged in that position. The deformity is liable to return, and though it become permanent the use of the limb is not seriously impaired, since it adapts itself to the circumstances.

DISLOCATIONS OF THE HEAD OF THE ARM-BONE (*Humerus*).

The head of the humerus in its natural position rests in the glenoid cavity (p. 62) of the scapula immediately under the acromion process (see Fig. 20, p. 61). It may be dislocated in three directions: (1) *downwards*, below the socket, into the arm-pit; (2) *forwards* in front of the socket, and slightly downwards; and (3) *backwards* on to the scapula, beneath its spine. The first form is called *sub-glenoid*, under the glenoid cavity, and is rare. The second form brings the head of the bone under the coracoid process of the scapula, and is called, therefore, *sub-coracoid*. *It is common.* The third form is called *sub-spinous*, because the head of the bone is under the spine of the scapula. It is very rare.

The second or sub-coracoid form is common because it is downwards and in front that the joint is least covered in and protected, muscles and bony processes guarding the joint in other directions.

The cause of the dislocation is most frequently a fall with the arm outstretched, the force being communicated along the arm, which acts as a lever. Occasionally direct violence forces the head of the bone downwards and forwards, a blow or fall on the shoulder for instance.

It is an accident of middle and advanced life, rare in childhood, though capable of being produced during that period of life by pulling and twisting. For instance, a mother or nurse may produce the accident when walking in the street holding a child by the hand, by suddenly and with a jerk pulling up the child if it slips, especially when stepping down off the curbstone.

The **Sub-coracoid** being the common form will be first described (Fig. 53).

Signs.—The roundness of the shoulder is gone, the tip of the shoulder projects outwards, and immediately beneath it, instead of the head of the bone, is a hollow. If the limb be raised the fingers can detect, in the arm-pit, a round body which rotates when the arm is bent at the elbow and turned outwards. The elbow sticks out from the side, and cannot be brought close. There is inability to move the arm at the shoulder, pain in the region of the joint, and sometimes numbness spreading down the arm to the finger owing to the head of the bone pressing on nerves. The limb is slightly shortened. The distinguishing features between dislocation of the head of the humerus and fracture of its upper end have been mentioned under Fracture of the Humerus (p. 84).

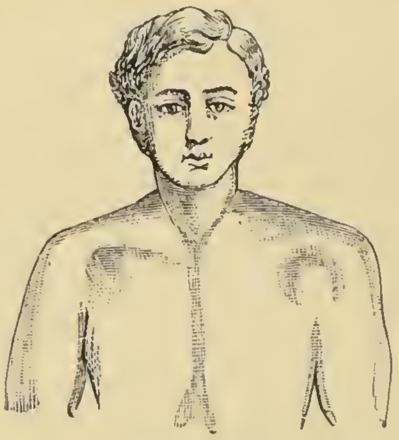


Fig. 53.—Sub-coracoid Dislocation of the Left Shoulder.

Treatment.—Strip the patient and place him sitting in the usual position in a chair. Let the operator stand behind him with one hand over the shoulder-joint to fix the shoulder-blade. He then rests his foot on the edge of the chair, and thus brings his knee well up into the arm-pit, allowing the injured arm to hang over his leg. With the other hand he seizes the patient's arm near the elbow and depresses it steadily over his knee. The knee thus acts as a fulcrum, and the bone returns to its socket

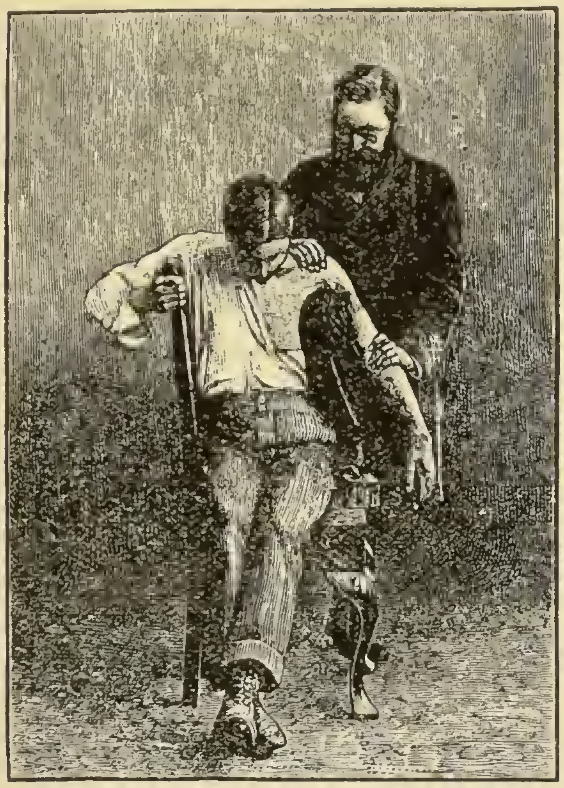


Fig. 54.—Method of reducing Dislocation of the Shoulder with Knee in Arm-pit.

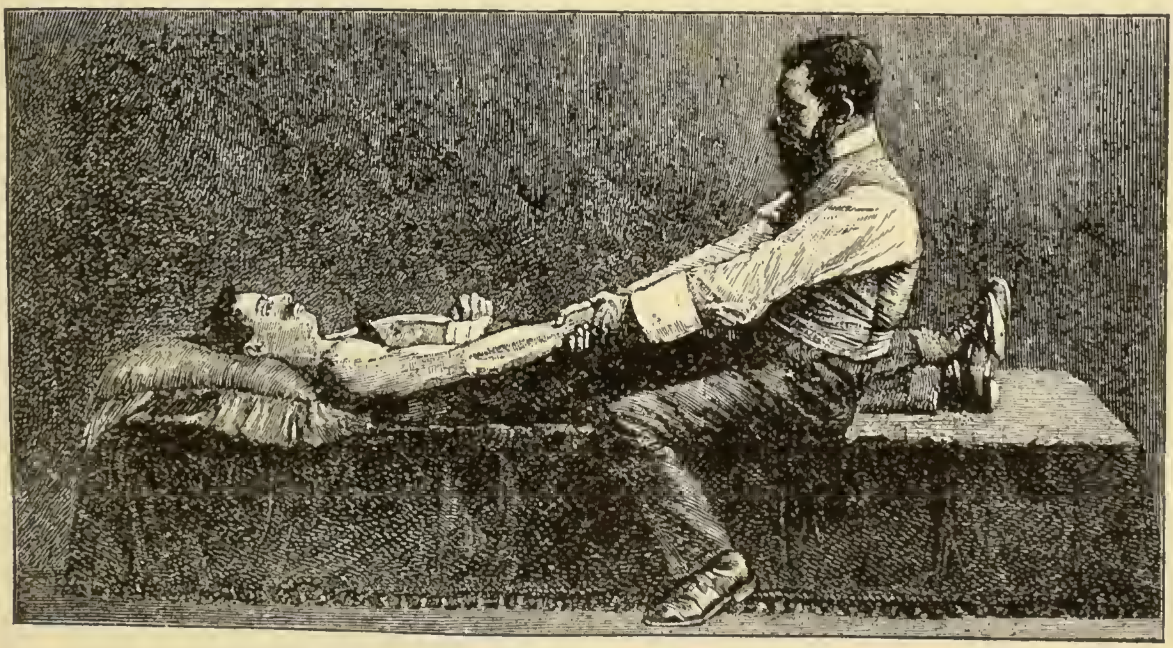


Fig. 55.—Reduction of Dislocation of the Shoulder by the Heel in the Arm-pit.

with a jerk. Fig. 54 shows this method. Greater force may be obtained by laying the patient on his back on a couch. The operator sits on the edge of the couch by the affected side, and puts the heel of the foot next the patient well upwards and backwards into the arm-pit so as to fix the shoulder-blade with it. The boot must of course be removed. The arm is then grasped by both hands of the operator by the wrist or elbow, and pulled *firmly* and *steadily* downwards over the heel, which at the same time presses the head of the bone outwards. As soon as the reduction is complete, which is known by the loud snap, the extension should cease, and the forearm be brought across the chest, and there bandaged. This method is represented in Fig. 55, and is known as the method of the heel in the arm-pit. If pulling by hand on the wrist or elbow is not sufficient, greater power may be obtained by a large towel or skein of worsted arranged in a clove-hitch (see Fig. 56) fastened above the elbow. The force exerted by the clove-hitch may be further increased by tying the ends and throwing the loop over the head, letting it come round the back. The pulling can then be done by the back. In making extension it must always be remembered that the pulling must be steady and continuous so as to tire out the opposing muscles. If several days have elapsed since the accident, chloroform is advisable, supposing one competent to administer it be present. After a longer period it is necessary. A person may himself reduce his dislocated shoulder by the method represented in Fig. 57.

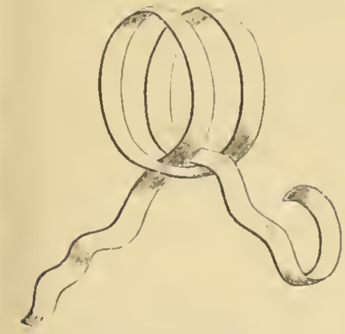


Fig. 56.—Clove-hitch.

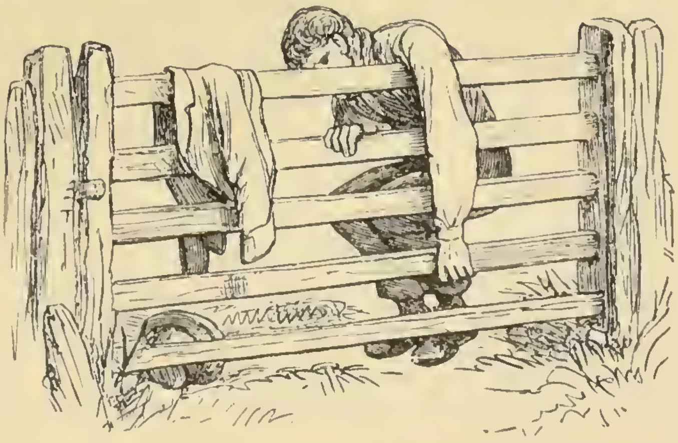


Fig. 57.—Mode of reducing a Dislocated Shoulder without assistance.

Sub-glenoid Dislocation (p. 62) presents similar signs to sub-coracoid, except that the arm is lengthened (Fig. 58). The treatment is identical, namely, the method by the heel in the armpit.

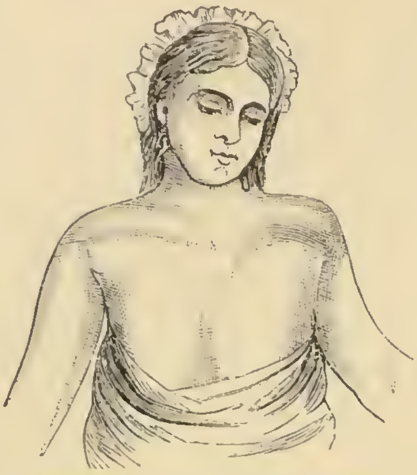


Fig. 58.—Sub-glenoid Dislocation of Left Shoulder.

Sub - spinous Dislocation is easily made out by the forward projection of the elbow, and the fulness behind the joint, where the head of the bone can be felt on the back of the shoulder-blade.

Treatment. — The extension in this case must be made *forwards*, but the principles on which the reduction is effected are the same. The forward extension is easily effected after rolling the patient on to the dislocated side and supporting him in that position by a pillow under the sound side.

In all these cases, after reduction, the arm should be bandaged to the side and supported by a sling for some days to permit of irritation of the joint being allayed and the healing process being established. Violent exercise of the joint should be carefully avoided for months, even always, since the accident will occur again more easily. Swelling and pain after reduction should be relieved by warm fomentations and rest.

Neglected cases can be properly and effectually treated only by skilful surgeons.

DISLOCATIONS AT THE ELBOW-JOINT.

The two bones radius and ulna may be dislocated together, or one of them separately. When both are together the dislocation may be backwards, or forwards, or to one side or other. The ulna may be displaced backwards alone and the radius forwards alone. Some of these varieties are very rare, because, owing to the formation of the elbow-joint, some of them would be extremely difficult to produce without great injury of other kinds to the joint. The commoner forms are dislocation of both bones backwards and dislocation of the radius alone forwards.

Dislocations of both bones backwards are commonest in childhood and youth. They are often due to a fall on the hand, the elbow being at the time bent. They can be produced by a blow on the lower part of the upper arm from behind driving it forwards, the elbow being fixed.

Signs.—The forearm is bent and fixed. The point of the elbow projects greatly behind, and above the projection is a hollow. In front the lower end of the upper arm-bone stands out prominently, and is pressed down into the bend of the elbow. (See Fracture of Lower End of Humerus for the distinguishing features between it and this dislocation, p. 85.)

The signs of **ulna displaced alone** are the same, but exist only on one—the inner—side of the joint.

Treatment.—The simplest method is shown in the figure (Fig. 59). The patient is seated in a chair, the operator's foot rests on the chair, and his knee is placed in the bend of the patient's elbow, resting on the upper end of the forearm, *not on the lower end of the upper arm.* The person's hand is then grasped, and the arm pulled round the knee. Another method is to permit one person to hold the upper arm fixed, while a second pulls on the forearm till the bones have been brought down into position. After reduction the arm should be kept in a sling for some days at least, and movement only gradually practised.

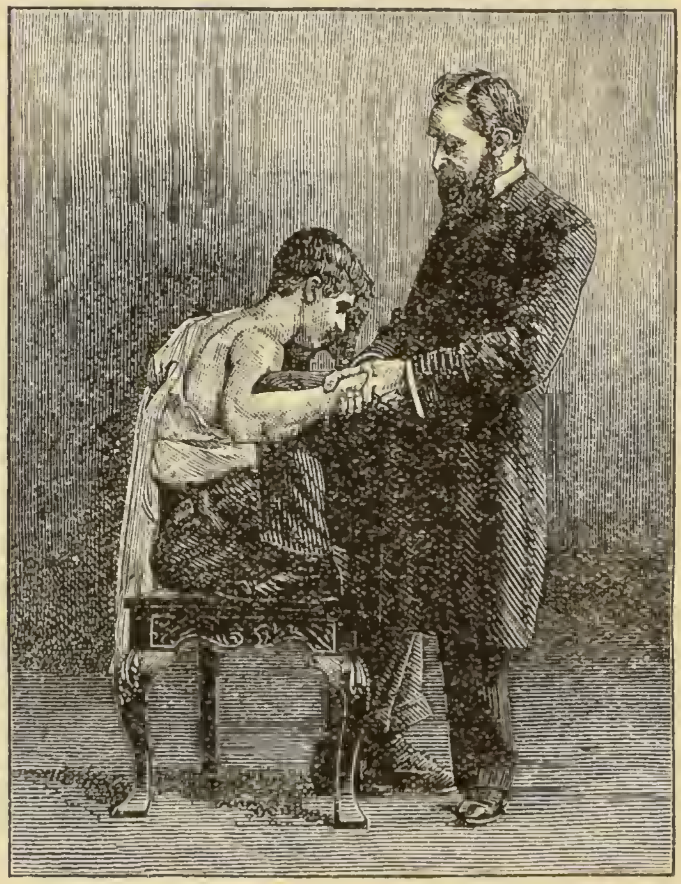


Fig. 59.—Reduction of Dislocation at Elbow.

Dislocation of the Radius (p. 62) **alone** is generally forwards. It has frequently occurred in young children from a violent pull, as when they are lifted off the ground by the hand.

Signs.—The elbow is slightly bent, further bending being prevented by the upper arm-bone coming against the displaced end of the radius. Straightening of the arm causes pain. The head of the bone—the radius is on the thumb side—can be felt in its unusual position; and that it is the radius can be easily made out by turning the wrist with one hand while the fingers of the other hand are over the displaced end, which is then felt to turn.

Treatment.—Let an assistant, standing behind the patient, fix the upper arm. Press both thumbs down on the projecting head of the radius, and, at the same time, with the fingers grasping the forearm round about, pull on the forearm, and then bend it. The bone is reduced, but it comes out again very easily. If a pad over the reduced bone and a bandage fail to keep it in its place leave it alone. Through time the head of the bone gets absorbed, and the natural movement is restored.

DISLOCATIONS AT THE WRIST-JOINT.

Dislocation of the wrist-bones on to the forearm is now known to be extremely rare. Cases mistaken for it are most frequently cases of Colles' fracture of the radius.

The forms described are *backwards*, which, if it occurred, would be recognized by the mass of bone on the back of the forearm, projection of forearm bones in front, and bending inwards of the fingers on the palm, and *forwards*, when the mass of wrist-bones is in front and forearm bones behind.

To distinguish between fracture note the position of the projecting processes—styloid processes—of ulna and radius, one on the inside, the other on the outer side of the joint. If it is a dislocation these remain connected with the forearm, if a fracture they are displaced in the grip of the wrist-bones. See FRACTURE OF THE LOWER END OF THE RADIUS AND ULNA (p. 86).

The **Treatment** is simple extension by pulling on the hand and pressure exerted in the proper direction on the displaced wrist-bones. To retain the bones in position bandage the hand and wrist in a splint and suspend in a sling.

Sometimes one of the bones of the wrist—the os magnum, generally—is displaced from its connection with the others. Manipulation will restore it, and a firm pad must be worn over it for a time.

DISLOCATIONS OF THE THUMB AND FINGERS.

Dislocations of the Thumb are not infrequent, because of the liability of the thumb to injury from falls. The common form is backwards, but dislocation forwards may occur. The thumb consists of three bones—the metacarpal, connected with the bones of the wrist, and two phalanges (see Fig. 23, p. 62).

Now dislocation may occur at the joint between the wrist and metacarpal bone, or at the joint between the metacarpal bone and the first phalanx, or at the joint between the two phalanges.

The first is not common, the second and third are more common. The deformity in the second form is evident, the inner end of the first phalanx lies on the back of the outer end of the metacarpal bone, which projects strongly towards the palm. The thumb has thus got a peculiar double bend, and stands outwards sharply from the palm.

Treatment.—The difficulty in reduction is to get a large enough surface on which to make extension. If simple pulling by grasping the dislocated thumb with fingers and thumb, at the same time forcibly depressing the point of the thumb and drawing it downwards and forwards, is not sufficient, then place a clove-hitch (Fig. 56) on the thumb and pull with it. When these have failed, then a thin strip of hard wood may be taken, 10 inches long and rather more than 1 inch wide, and shaped as shown in the figure (Fig. 60). At one end a series of holes is cut, through which strong tape about a yard long is passed, a separate piece of tape being required for each pair of holes. Loops are thus formed on one side of the wood which secure the thumb laid along the wood. Extension can then be practised by pulling on the wood to which the thumb is fixed; and the reduction may be aided by bending backwards or forwards as may be required. Sometimes all these measures fail, owing, it is supposed, to the end of the bone being held by one of the muscles of the thumb, which must be cut before the bone can be returned.

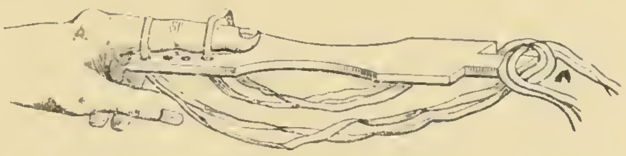


Fig. 60.—Apparatus for Reduction of Dislocations of Thumb and Fingers.

Dislocation of the tip of the thumb may often be reduced by pressing the displaced end forwards with the thumb. After reduction a bandage should be applied to the thumb.

Dislocations of the Fingers are less frequent than those of the thumb. They also are backwards and forwards, usually backwards. They are easily recognized, and should be reduced by the methods described for the thumb.

DISLOCATIONS OF THE THIGH-BONE (*Femur*).

Considering the depth of the socket in which the head of the thigh-bone moves, and the powerful muscles by which it is surrounded, this bone is dislocated with great frequency. This is, doubtless, because of the great range of movement permitted by the joint and the long leverage supplied by the leg to any displacing force. It requires both considerable force and a certain position of the limb to effect it. The accident is commonest in middle life, but may happen to children.

There are two classes of dislocation: I. One class, in which the head of the bone, displaced from its socket, rests *behind the socket;* and II. Another class in which it rests *in front of the socket.*

I. In the **backward displacement** it will be seen from Fig. 61 that the head of the bone, displaced from its socket (*a*), may lie (1) on the back of the iliac portion (A) of the hip-bone, in which case, besides being backwards, it is also upwards; or (2) the head of the bone may slip down and rest on the notch between the ilium and ischium, the sciatic notch (behind B in the fig.), and in this case the displacement is backwards, and not nearly so much upwards as in the former case.

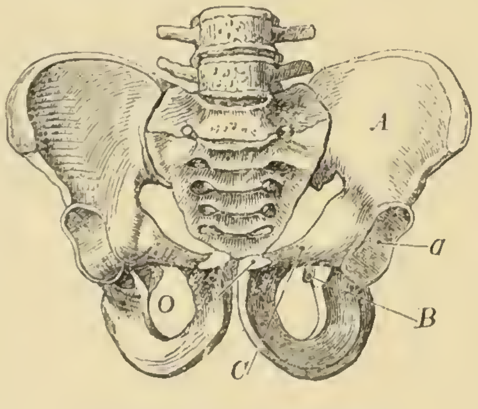


Fig. 61.—The Pelvic Bones.

II. In the **forward dislocations** (1) the head of the bone may drop down into the obturator foramen (O), or (2) it may be pulled upwards so as to rest on the body of the pubis (C).

I. (1) The common form is **backwards** and **upwards**, on the back of the ilium.

It will be easily understood that if the thigh be bent strongly up on the body, or, what is the same thing, the body bent, as in the stooping posture, and the limb at the same time brought close to the middle line of the body, the head of the femur will be brought to such a position in its socket that a sudden force may twist the bone out of the socket from its under side up on to the back of the hip. This is indeed the frequent way in which the dislocation is produced—a heavy weight, say a mass of earth, falling on the back whilst the body is bent forwards.

Signs.—When the patient stands on the sound leg the affected limb is seen to be shortened and turned inwards, so that the knee is in front of and above that of the unaffected side. The limb is slightly bent and supported by the toe, which rests on the opposite *instep* (Fig. 62, *a*). The head of the bone being directed backwards, and resting on the back of the hip, causes a marked prominence in that region, while the great trochanter, the process of the thigh-bone, which should project directly outwards, is now felt in front. The limb cannot be moved by the patient, and only very slightly by another person, and then with great pain. For distinctions between this accident and fractured thigh refer to Fracture of Upper End of Femur, and see Fig. 44.

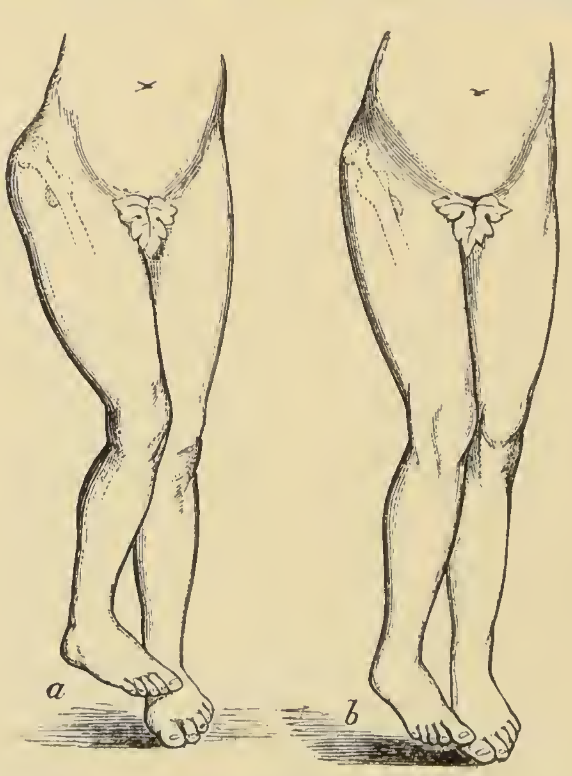


Fig. 62.—Dislocation of Hip, backwards and upwards. *a*, On to the Ilium. *b*, On the Sciatic Notch.

(2) The second form of this dislocation, in which the head of the bone rests on the sciatic notch, is a variety of (1), and is not half so frequent.

Its **Signs** are similar to those of (1), but less marked, as may be seen by reference to Fig. 62, *b*. The shortening is less, rarely exceeding ½ inch, while the shortening in the first form may be from 1½ to 2½ inches. The point of the great toe rests on the *ball of the great toe* of the opposite side, a considerably less amount of support than in the former case. The projection backwards of the head of the bone is also less marked. These differences are well represented in the figure.

Treatment.—The treatment of both these forms is the same. Formerly sheer force alone was resorted to to effect reduction. Fig. 63 represents this method, in which the hip is fixed by a band passing between the legs and over the dislocated thigh, pressing, on the inside, against the front of the hip-bone, *not against the thigh-bone.* The band is attached to a staple in the wall or on the floor behind, and rather below the patient. Then, a padded leather belt is buckled to the lower part of the thigh and attached to one end of a pulley, which is fixed to the wall in front of the patient. The knee should be slightly bent and carried across the opposite thigh, as represented in the figure. The pulley or extending force, and the band or counter-extending force, should act in the same straight line, and that ought to be the line of the displaced limb. When they are adjusted properly in this way extension is to be made by pulling slowly and steadily on the pulley until the head of the bone is brought down towards its socket, into which it may be caused to slip by gently rotating the limb. It sometimes catches on the edge of the socket, over which it may be lifted by means of a towel passed under the thigh as near the joint as possible. This method by force is, at least in recent cases, now superseded by a method by manipulation. It has been pointed out that the action that displaces the thigh-bone backwards is one which forcibly twists the limb inwards when it happens to be bent up on the body and carried towards the middle line. In other words, the dislocation is produced by flexion, adduction, and rotation *inwards.* Now, by reproducing these manœuvres and reversing one of them the bone may be returned to its place. Thus the limb is bent, that is flexion; the knee is carried over the opposite thigh, that is adduction; but just at this point the dislocating action is reversed, and the limb is rotated *outwards,* so that the head of the bone is caused to return to the socket along the same path as that on which it had passed out from the socket, and is rolled back to its proper place. To carry out this procedure the patient is placed on his back. The operator stands in front of him, and, taking the affected limb, bends the knee on the thigh and the thigh on the body, and carries the knee so that it points over the opposite thigh. He then grasps the ankle with one hand and the knee with the other, and carries the limb upwards to and over the belly, passing outwards in a half sweep, and so back to its old position alongside the other leg. The rolling of the limb outwards must not be carried too far, lest the head of the bone be not rolled into its socket but round it, and the dislocation be changed from one backwards to one forwards. The sweep should, therefore, not be carried further outwards than the side of the body (Fig. 64).

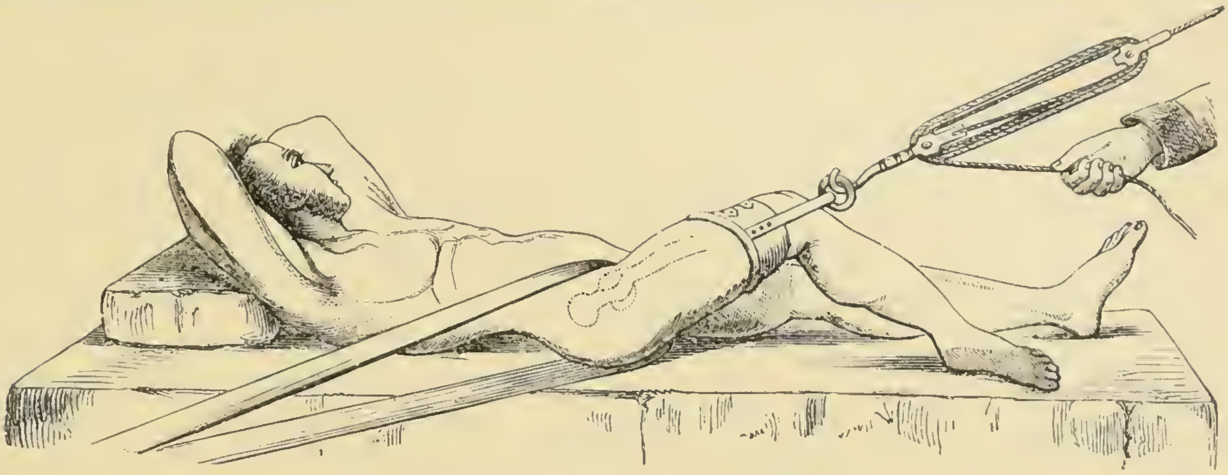


Fig 63.—Reduction of Dislocated Thigh by Pulleys.

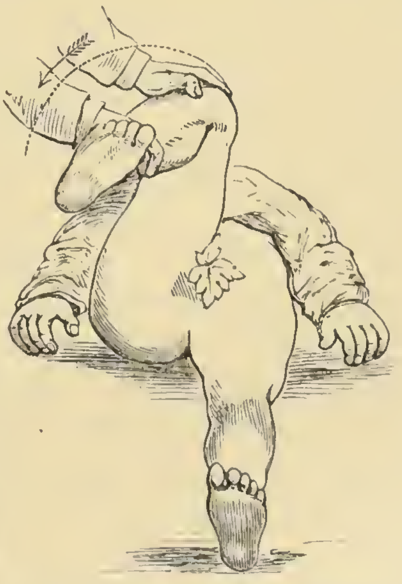


Fig. 64.—Reduction of Dislocation of Hip by Manipulation—flexion, adduction, and rotation *outwards.*

Another and simpler method, described as the "ready method," may be practised before trying the method by manipulation. It consists in laying the patient on his back on the ground.

Let the operator stand over him, with the patient's injured leg between his legs, so that the ankle is between his thighs and the back of the foot pressing on his buttocks. Then the operator clasps his hands below the patient's bended knee, and by this means slowly lifts till the lower part of the patient's body is raised from the ground. After holding him so a few seconds he may hear the snap, which indicates the return of the bone to its socket. If this fails, then try manipulation; if manipulation fails, pulleys may be necessary, but these should be used only by a surgeon. Chloroform is also frequently necessary.

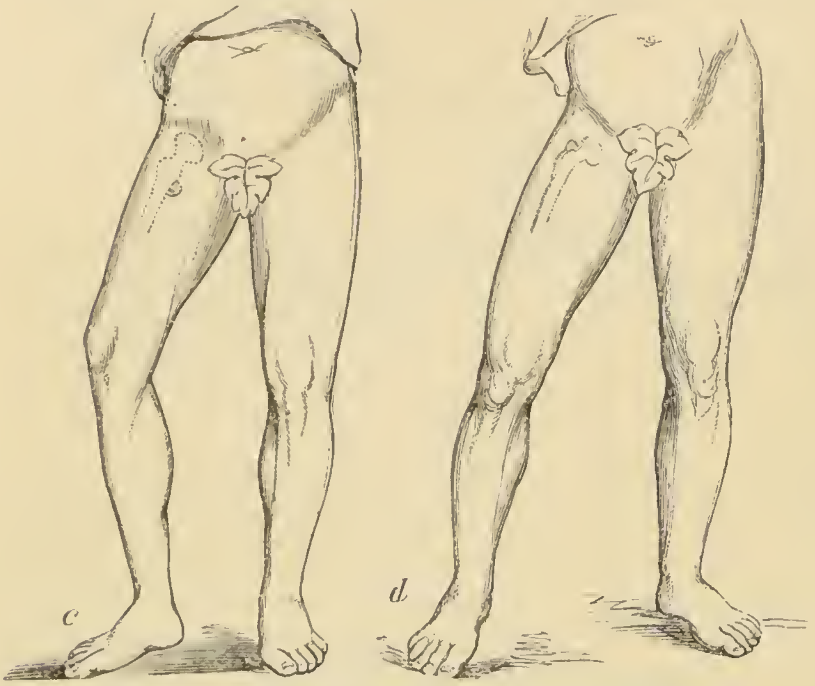


Fig. 65.—Dislocations of Hip forwards. *c*, On body of Pubis. *d*, Into Obturator Foramen.

After reduction the limb should be strapped to its fellow, and the patient kept at rest in bed for a fortnight.

II. The dislocations **forwards** are infrequent.

(1) When the dislocation is into the obturator foramen (o, Fig. 61) the limb is *lengthened* about 2 inches, drawn away—abducted—from the other, and in advance of it, and the foot points directly forwards. The body is bent forwards, and to the injured side. See Fig. 65, *d*.

(2) The second form, where the head of the bone rests on the body of the pubis, is the least frequent of all the dislocations of the hip.

Signs.—The limb is shortened about 1 inch, drawn away from its fellow, and turned outwards (Fig. 65, *c*). The roundness of the hip is lost. On moving the limb the head of the bone is seen rolling high up in the groin. The person cannot straighten himself, because the head of the bone stretches the muscles passing down the front of the thigh.

The force that causes either of these two forms differs in the method of its application from that causing the two backward dislocations. A violent separation of the thighs from one another may cause the first, such as a heavy weight falling on the back and forcing the limbs apart. To produce the second the thighs must be stretched out—*extended*—when a sudden forcing of the body backwards will cause it, or a sudden extension of the thighs when the body is fixed. The kind of movement most fitted to produce it is a sudden drawing outwards of the extended limb—extension and abduction—combined with twisting of the leg *outwards*—rotation outwards. These are the exact opposite of the movements necessary to produce the backward dislocations.

The **Treatment** by manipulation is best, and applicable to both. It takes into view the movements that cause the dislocation, and reverses them to some extent. Thus the dislocating movements have been considered as extension, abduction, and rotation *outwards*, and therefore the manœuvres of reduction must be forced extension, abduction, and rotation *inwards*. The patient lies on his back, the operator stands over him, and grasps the ankle with one hand and the knee with the other. The thigh is bent so as to be perpendicular to the body, and the knee is bent. The limb is then taken well out from its fellow and carried in a sweep *inwards*, rotating the bone towards the body, the sweep ending when the limb is brought down straight alongside of the other (Fig. 66). In performing this movement one is apt, instead of reducing the dislocation, to convert it into one on the back of the hip, owing to the head of the bone travelling round the outside of its socket. If this has happened the manipulation for backward dislocation must be employed, and, to prevent the bone simply rolling round the socket, a towel may be used under the thigh with which to lift

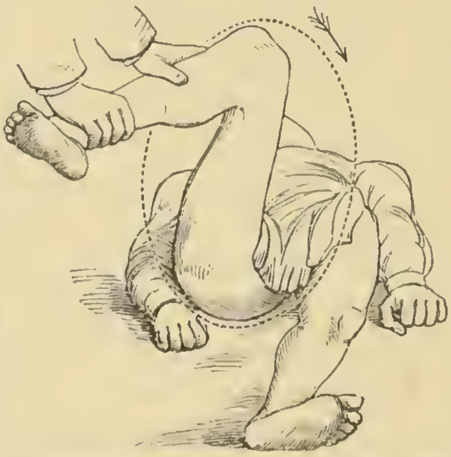


Fig. 66.—Reduction of forward Dislocation of the Hip by Manipulation—extension, abduction, and rotation *inwards*.

the head of the bone over the edge, as already described.

Another method of reducing (1) is to place the patient in bed with a bed-post close up between his legs, a small pillow being interposed between the post and the person. The operator stands on the sound side, and, passing his hand under the sound leg, grasps the ankle of the injured side, and pulls the foot and leg inwards across the middle line. By this means the bed-post is made to act as a fulcrum and the leg a lever for forcing the head of the bone outwards into its place. The object of passing the hand *under* the sound leg is to prevent raising the foot of the injured side, which would cause the head of the bone to roll round the socket into a notch behind. As in the former cases, after reduction the two legs should be bound together at the knee, and the patient should rest in bed for two weeks.

Congenital Dislocation at the Hip is considered in the Section on DISEASES OF CHILDREN.

DISLOCATIONS AT THE KNEE-JOINT.

The bones that form the knee-joint have been noted on p. 63. It is to be remembered that the joint is formed by the lower articulating processes, or condyles, of the hip-bone, and the surface of the head of the tibia, that between these two there are crescent-shaped plates of fibrous gristle, and that the joint is strengthened by a large number of strong ligaments. Two ligaments—the crucial ligaments—are within the joint; the others surround it. The joint is protected in front by the patella or knee-pan, which has a ligament connecting its lower border with the tibia, and is attached by its upper border to the straight muscle that passes down the front of the thigh. The knee-pan glides up and down on the front of the joint. Now there may be dislocation of the pan, or dislocation of the tibia.

Dislocations of the Knee-pan.—The bone may be displaced to one side or other, or upwards, or it may be turned up on one of its edges. None of these occurrences is very frequent, but of the four forms the displacement outwards is the most common. It is most frequently due to falling on the inner side of the knee, but may be caused by sudden contraction of the straight muscle attached to the bone, as when a person makes a sudden jump, or a sudden effort to recover himself after a slip.

Signs.—On comparing the affected knee with the opposite side one observes a great difference in shape, and examination with the fingers shows the knee-pan lying over the outer or inner condyle of the thigh-bone. The limb can neither be bent nor straightened, but is fixed in a slightly bent position. The breadth of the knee is increased.

When the bone has been drawn *upwards*, which is very rare, and cannot occur without tearing its ligament, it is found above the joint, and a hollow is in the place it ought to occupy.

With displacement *edgeways* a prominent body, which can be grasped by the fingers, is seen standing out under the skin. In this case the limb is immovably fixed in a straight position.

Treatment.—For *outward* or *inward* displacement, place the patient in a sitting posture, raise the leg, so that the heel rests on the shoulder of the operator, and push on the knee-cap with the fingers so as to restore it to its place.

Upward displacement requires to be treated as fractured knee-cap.

Displacement *edgeways* ought not to be treated till it is found which is the upper and which the lower surface of the bone. The upper surface may look outwards and the under surface inwards, or the reverse may be the case, and unless the position is made out the bone might be turned upside down. The best way of coming to a decision is to learn the direction of the dislocating force. If the force came from the outside it would be the upper surface that would look inward. Having found this out, put the patient in the same position as before, raise the heel and push the bone over with the thumbs.

After reduction the limb should be kept at rest in the extended position for some days at least, hot or cold cloths being applied if pain or any signs of inflammation exist. When the person begins to move about it is well to make a thick covering for the knee, which should be worn for several months.

Dislocations of the Shin-bone (*Tibia*).—Partial dislocations of the tibia to one side or the other with a slight turning of the bone may occur as the result of sudden twists given to the leg—for instance, by the foot being caught in a hole, or by blows on the side of the limb. Complete dislocation backwards or forwards seldom occurs, however, without such destruction to the joint and structures in its neighbour hood as to demand special surgical treatment, because such a dislocation requires great force for production.

The **Signs** of the *side displacement* are so marked as to be easily observed. The leg and thigh are no longer in the same straight line, the tibia being displaced to one side; there is a bony prominence at one side owing to the new position of the head of the bone; and the joint is greatly increased in breadth.

The signs of displacement *backwards or forwards* are equally marked. When it is backward, the shin-bone forms a projection in the ham, while the lower end of the hip-bone is very prominent in front, with a deep hollow *below;* when it is forward, the swelling in the ham is due to the condyles of the thigh-bone, that in front is owing to the head of the tibia, and the deep hollow is *above* the tibia. The leg is in both cases shortened. Besides these signs there are others due to the injury done to the soft parts round the joint. In particular the blood-vessels at the back of the joint may be severely pressed upon or injured, so severely sometimes as to arrest the circulation below the seat of injury and produce mortification of the limb. Nerves also may be harmed and numbness result.

Treatment.—For partial dislocations pulling from the ankle, combined with direct pressure on the head of the bone, is generally sufficient to return it to its place. For complete dislocation extension must also be practised from the ankle, the thigh-bone being fixed, and pressure being exerted on the head of the tibia in a downward, and on the condyles of the thigh-bone in an upward, direction. Great care must afterwards be taken of the joint. It should be fixed and kept quiet for several weeks by means of a splint, or by being laid in a long box carefully padded, and, to allay inflammation, an ice-bag should be applied over the joint, flannel intervening between the skin and the bag. After recovery a firm bandage or elastic knee-cap should be worn.

Displacement of the Cartilages of the Knee-joint.—The half-moon shaped pieces of cartilages interposed between the thigh and leg bones sometimes become displaced. This accident generally happens after the cartilages have been affected by inflammation of the joint, a trifling cause, such as a slight twist of the foot when walking, being then sufficient to produce it.

The **Signs** are sudden and severe pain in the joint, which the patient cannot straighten. In a short time swelling and inflammation occur.

Treatment.—The patient having been laid on his back, grasp the limb in one hand, supporting it with the other hand in the hollow behind the joint, bend the knee to its utmost, and then suddenly straighten it, twisting the leg slightly backwards and forwards. If this is successful the patient has the use of the joint restored at once. It sometimes entirely fails, and the only remedy is to give support to the joint by a knee-cap. Sometimes a sudden accidental movement replaces .the cartilage, after manipulation has failed.

Dislocation of the Clasp-bone (*Fibula*).—The head of the fibula lies just below the knee on the outside of the leg, and displacement can be readily made out.

The **Treatment** consists in strongly bending the knee, and pushing the bone back into position with the fingers. A pad should afterwards be placed over the head of the bone and secured by a bandage. This should be retained for two months.

DISLOCATIONS AT THE ANKLE-JOINT.

The lower end of the shin and clasp bones together form a sort of arch which embraces the surface of the bone of the foot called astragalus or ankle-bone (Fig. 27, p. 64). The tibia on the inside and the fibula on the outside have projecting processes, the internal and external malleoli, which grasp the ankle-bone, so as to prevent any movement from side to side and limit it to a to-and-fro motion. The articular surfaces are further held in apposition by a ligament on each side, and one behind and in front. It will be readily seen, therefore, that the foot cannot be displaced from the leg to one side or other without breaking off one of the malleoli. In dislocation *outwards* part of the clasp-bone is broken off, producing the fracture known as Pott's which has been already described (p. 95); and in dislocation *inwards* a similar fracture of the shin-bone occurs. The latter is more serious because the force producing it requires to be greater. Both of them require to be treated as fractures.

Dislocation *backwards* is produced by jumping from a carriage in motion, or by a force which acts similarly by fixing the foot while the leg-bones are pushed forwards.

Signs.—The foot being pushed back the leg-bones are jerked forwards, and the distance between them and the toes is diminished, so that the back of the foot is shortened, and the heel lengthened. The toes are pointed down, the heel up. Forward dislocation is almost never seen. The signs would be the reverse of those of backward displacement.

Lastly, a form of dislocation exists in which the two bones are widely separated and the ankle-bone forced up between. It is accompanied by very great injury.

Treatment.—All these dislocations are reduced by pulling on the foot, the leg-bones being fixed, combined with proper manipulation. Afterwards a splint would be applied, preferably of some material easily softened by heat, so that it might be carefully moulded to the joint. This, well padded, would be so fixed as to permit of hot or cold applications being applied to keep down the inflammation, almost certain to occur in so severe an injury.

But the greatest difficulty in such cases, where the damage to the structures about the joint is so great, is to restore freedom of movement to the joint. It is impossible for repair of the soft parts around the joint to take place without adhesions forming, and tendons and ligaments being matted together, more or less, according to the amount of injury. These adhesions limit the joint movements and sometimes prevent them altogether. It would, therefore, as a rule, be necessary to remove the splints comparatively early, and gently to move the joint by manipulation, to break down the adhesions, while they are still soft: so that, after all risk of inflammation has passed away, it would be better to substitute a splint that can be easily removed and re-applied, to permit daily manipulation and massage. Sometimes it is necessary to give chloroform in order to break down the adhesions, and afterwards by manipulation to keep them from re-forming. At what time after the injury this should be done requires experienced judgment to decide, so that medical advice ought to be obtained whenever possible.

DISLOCATIONS OF THE BONES OF THE FOOT.

Dislocation of a Tarsal Bone.—In the former dislocation the astragalus was separated from the bones of the leg, but it may retain its connection with the leg-bones and be separated from the other bones of the foot, from the heel-bone with which it is connected below, and from the scaphoid with which it unites in front.

The dislocation may be backwards or forwards (the latter very rare), outwards or inwards.

When dislocated *backwards* the foot is lengthened behind, and the ankle-bone is forced on to the instep, and when *outwards*, the foot rests on the inner border, the outer being raised, and there is a projection inwards of the tibia with the astragalus in its grip. In the inward dislocation of the foot, the fibula and astragalus form an outward projection, and the foot rests on the outer border, the inner being raised.

Treatment.—Fixing the leg-bones, pulling on the foot, and pressure exerted on the displaced bones will usually reduce them. Sometimes reduction is very difficult owing to wedging of the astragalus; and cutting through of certain tendons may be necessary. The after-treatment is the same as for other dislocations.

Dislocations of the Metatarsal Bones.—These sometimes occur as the result of great violence. Extension, counter-extension, and manipulation, as described for dislocation of the tarsus, are the proper means of restoring the bones to their position.

Dislocations of the Bones of the Toes (*Phalanges*).—The bones of the toes are seldom displaced; when they are, the displacement is upward, and is frequently combined with fracture. The treatment is the same as for reduction of dislocated fingers, the apparatus figured on page 61 being specially necessary.

SECTION IV.

THE MUSCLES, TENDONS, AND BURSÆ.

THEIR STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

Voluntary Muscle:
Microscopical Structure;
Chemical Constitution—rigor mortis;
Properties—Irritability or power of responding to a stimulus, power of doing work, production of Heat and Electricity, Elasticity, Tonicity.

Involuntary Muscle:
Microscopical Structure.

Particular Groups of Muscles—of head and neck—of the back—of the chest—of the upper extremity (shoulder, arm, forearm, and hand)—of the abdomen—of the lower extremity (thigh, leg, and foot).

Sheaths of Tendons.

Synovial Sacs or Bursæ.

CHARACTERS OF MUSCLE.

See Plate I.

While the bones form the framework of the body, the main bulk of the substance which clothes them consists of muscular tissue, what is termed flesh, which forms about two-fifths of the entire weight of the body. Muscular tissue does not cover and surround the bones in continuous sheets, but is collected into masses, varying in size and length, and arranged in different ways. Each separate mass is called a muscle, and is divided off from its neighbours by partitions of connective tissue. Each muscle is supplied with blood-vessels, and with other vessels called lymphatics and nerves, which also have their sheaths of connective tissue; and vessels and nerves also run between muscles on their way to other parts. Over the muscles is a continuous sheet of fibrous tissue, having embedded in its substance a large number of fat cells. It is called **fascia**, and it not only covers over all the muscles, but fills up to some extent inequalities of surface, and gives a rounded and regular appearance. Finally, outside of all is the skin. So that if a limb were to be examined, say an arm, after the outer covering of the skin had been removed, the fascia, presenting a fatty appearance, would appear. When it in turn had been stripped off, the various muscles would be revealed, inclosed in their sheaths and separable from one another. On pushing some of them aside vessels of various size and nerves would be visible, and not till the muscles had been stripped off would the bones be uncovered. Of course in some places, and particularly in the neighbourhood of joints, the bones come very near the surface, being covered by little else than fascia and skin.

The muscular tissue forming the masses is red in appearance, and it is therefore called **red muscle**. But there is another kind, called **white muscle**, found in the walls of blood-vessels, in the coats of the stomach, bowels, and bladder, in the walls of the air-tubes of the lungs, and elsewhere. Both kinds of muscle are the active agents in motion; but the movement caused by red muscle, for instance the motions of our limbs in walking, which are due to contractions of the muscles of the leg, is a movement controlled by our will, while the white muscle exists in organs also capable of contractions, but contractions quite independent of our will. For this reason the red muscle is also called **voluntary** muscle, and the white **involuntary** muscle. Red muscle presents, when viewed under the microscope, a striped or striated appearance, while the white is smooth and regular; the one is therefore called **striped** or **striated** muscle, and the other **unstriped, non-striated,** or **smooth** muscle. A third variety of muscle is found in the heart (p. 297).

STRUCTURE OF VOLUNTARY MUSCLE.

If a small piece of muscle be examined under a microscope it is found to be made up of fibres, each fibre inclosed within a delicate transparent sheath, the **sarcolemma**. Fig. 67 shows a single fibre which has been torn, the torn ends have separated from one another, and the delicate sheath is seen passing across between the two. Each fibre can be split up lengthwise into a number of little fibres or **fibrillæ**, or crosswise into discs. The striated appearance is explained by supposing that a muscular fibre is made up of two kinds of substances, one doubly refractive, the truly contractile substance, which exists in the form of minute columns or pillars (**sarcous elements**) set in rows across the breadth of the fibre, embedded among the second singly refractive and non-contractile substance. A very slight amount of the embedding material is present between the columns of a row, so that they present the appearance of a continuous dark band. But there is a considerable accumulation of the embedding substance at the ends of the columns of one row, separating them by a clear-looking interval from those of the next row. Thus the dark band alternates with a light band, and the appearance of a cross striation is produced. Delicate membranes, connected with the sarcolemma, cross the fibre like partitions, dividing it into compartments, and these partitions pass across in the region of the accumulation of embedding material, appearing as dark lines in the light band. It is only by special means that these details of a muscular fibre can be revealed. Fibres are collected into bundles and inclosed in a connective tissue sheath to form what is called a **fasciculus**; and a number of the fasciculi are bound together by a denser layer of connective tissue to form a muscle.

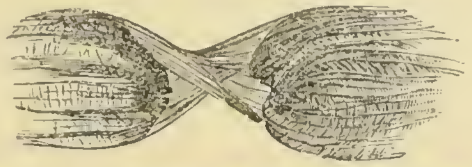


Fig. 67.—A Striped Muscular Fibre with its Sheath.

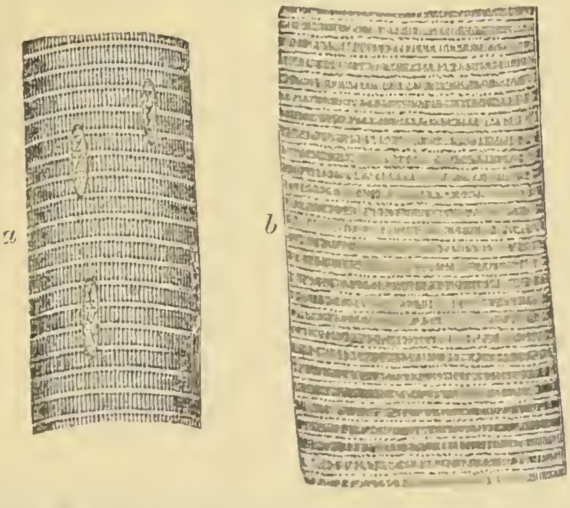


Fig. 68.—Muscular Fibre, *a* showing nuclei, and *b* the dark lines in the light band. In both are represented the minute columns mentioned in the text.

Muscle is richly supplied with very delicate thin-walled blood-vessels, which run up between the fibres and communicate with one another by cross branches. It is the blood that gives the red colour to the flesh. Nerves also are intimately connected with muscular fibres.

CHEMICAL CONSTITUTION OF VOLUNTARY MUSCLE.

Within its sheath a fibre in the living state is semifluid. The semifluid substance can be squeezed out, and is called **muscle plasma.** When allowed to stand the plasma coagulates, and then separates into a watery portion called **serum** and a solid portion or **clot**, which consists of a substance related to white of egg. The serum consists largely of water, but contains also a substance like white of egg, albuminous, that is to say, as well as animal starch, and salts, chiefly of potash, and waste substances formed by the action of the muscle. The clear semifluid substance of the fibres in the living state becomes after death opaque and coagulated. It is the occurrence of coagulation that produces stiffening of the body, or **rigor mortis** (the stiffness of death) as it is called, which comes on some time after the death of a person or an animal. The stiffening may come on *quickly*, within an hour or two after death or even sooner, if the person has died of an exhausting disease, and then it passes off quickly. The stiffening may be *long delayed*, as in the case of persons who have died in full vigour, by a sudden accident, for instance, and when it does at length occur it lasts long, and may continue even for several days. In both cases, after *rigor mortis* has disappeared, the muscles become soft and flabby, and decomposition ensues.

PROPERTIES OF VOLUNTARY MUSCLE.

I. The great property of muscle is *irritability* or the power of *responding when irritated.* The response is in the form of contraction, that is when the muscle is irritated or stimulated it responds by shortening itself, so that its ends are brought nearer and it becomes thicker at the middle. The muscle does not shorten itself all at once, but the contraction passes quickly over it in the form of a wave. The usual way in which a muscle is stimulated is by nervous action. The nerve-tubes end, it has been seen, in the fibres, and when an impulse reaches the fibres by the nerve the fibres become irritated and shorten themselves. Muscles, however, will respond to other than this usual stimulation. (1) Mechanical means, such as pricking or pinching, will irritate them and cause them to contract. (2) An electrical current has the same effect. (3) Heat also is capable of producing contractions as well as (4) chemical irritations. The purpose of contraction is obvious. If one end of the muscle be fixed, and the other attached to something which is free to move, when the muscle shortens itself it will bring whatever is attached to the one end nearer to the other.

A muscle will respond by a single contraction to each irritation if it be sufficient in amount, and will thereafter relax to be ready for the next contraction. Sometimes the irritations may follow so quickly after one another that the muscle has barely relaxed after one contraction when it is again called on to contract. If the irritations be still faster, then the muscle may not have time to relax at all between each one. The result is that the muscle remains contracted and rigid. This is the condition of a muscle in cramp, and is called **tetanus**. For instance, when a man seizes the handles of a galvanic machine while it is at work, if it be strong enough he finds he cannot let go, his fingers being firmly bent over them. This is due to tetanus of the muscles that bend his figures, tetanus produced by a series of galvanic shocks causing contractions, the shocks being so rapid that the muscles have no time to relax and remain strongly contracted.

It is to be noted that when a muscle contracts owing to the stimulus received from a nerve, it is not the nerve that supplied the force for contraction. The power of contraction is inherent in the muscle substance, and the stimulus only affords the opportunity for its display. The muscle has energy stored up within it as a barrel of gunpowder has energy stored up within it. The barrel of gunpowder, however, would stand harmless so long as it was left alone. As soon, however, as a lighted match is applied, the energy of the gunpowder is liberated and an explosion occurs. So the stored up energy of a muscle requires merely to be set free to perform work. The nervous stimulus acts the part of the lighted match in liberating the imprisoned force of muscle.

II. Muscles by their contraction are *able to do work*. Thus if to the end of the muscle that is free to move a weight be attached, when the muscle contracts it will lift the weight. It is found, curiously enough, that a muscle contracts better when it has some weight to lift than when it has none. Up to a certain limit, with increased weight there is increased work done. The increased resistance seems to call forth increased action of the muscle. When the limit has been passed the muscle quickly fails. Similarly a muscle works best with a certain degree of rapidity, but if the irritations follow one another too quickly, if the contractions are too rapid, the muscle becomes exhausted and *fatigue* arises. "It is the pace that kills."

III. Muscles *develop heat* by contraction.

IV. Living muscle has been shown to *possess a certain amount of electrical force*, which is diminished by contraction, but increases again with rest.

V. *Elasticity* is a property of this tissue, a property in virtue of which the muscle, after stretching, is capable of returning to its previous length.

VI. By *tonicity* is meant the condition of tension in which a muscle normally is. It is this condition of tension or tone that causes a muscle, when cut, to gape by separation of the edges of the wound.

TENDONS.

Muscles are connected with bones through the medium of tendon. The mass of flesh tapers off as it were towards the ends, where the fibres become merged into white fibrous tissue already described (p. 56). The tendon presents the appearance of a white glistening cord, or flat band, of considerable thickness. The mass of flesh composing the muscle is called the **belly** of the muscle. One end is usually attached to a bone more or less fixed, and is called the **origin** of the muscle. The other end is attached to the bone meant to be moved by the contraction of the muscle, and is called the **insertion** of the muscle. Sometimes the tendon runs down the centre of the muscle, and the fibres run obliquely into it, the tendon occupying the same position that the quill does in a feather. Sometimes again the tendon is spread out on the surface of the muscle in a flat expansion, in which case it is called an **aponeurosis**.

Fig. 69. A Spindle Cell of Involuntary Muscle.

INVOLUNTARY MUSCLE.
(White, Non-striated, or Smooth Muscle.)

This consists of spindle-shaped cells, having an elongated nucleus in the centre (Fig. 69). The cells are united to form ribbon-shaped bands, not masses like those of striped muscle. This kind of muscle responds much less rapidly than the former kind to irritations, and the wave of contraction passes over it more slowly. It is this form of muscle that is found in the walls of the stomach and bowels, and it is irregular and excessive contractions of the muscular walls of the bowel that produce the cramp-like pains of colic. Colic is, in fact, due to a cramp of involuntary muscle. The purpose of involuntary muscle in the walls of blood-vessels, stomach, &c., is mentioned in considering these organs.

CHIEF MUSCLES OF THE BODY.

(Plate X.)

There are several hundreds of separate muscles in the human body. It would be quite unprofitable to go over them in any detail. It may be well, however, to indicate generally how they are grouped, and to mention a few in particular.

MUSCLES OF THE HEAD, FACE, AND NECK.

Various thin muscles are disposed in the fore part of the head and scalp (Pl. X., *fig. 1*), by which the brows can be "knitted," and the scalp moved to a small extent. Several small muscles are attached to the back of the ear, which are largely developed in animals with long ears, enabling the ears to be moved.

A series of thin muscles is disposed over the face, in the eyelids, over the nose, and round the mouth, by whose contractions the various movements of the face are effected. They are called **muscles of expression**. When one side of the face is paralysed, these muscles are quite relaxed, and so that side of the face is quite unwrinkled and expressionless. The muscles of the unaffected side, being therefore unopposed, pull the face to that side by their tonicity.

The **temporal** muscle is a large fan-shaped muscle passing down the side of the head in front of the ear to be inserted into the upward projecting process of the lower jaw. Its action is to raise the lower jaw.

The temporal muscle forms one of a group of muscles called **muscles of mastication**, because they are chiefly concerned in the movements of the jaw in chewing. The other members of the group are the **masseter** and **pterygoid** muscles, passing downwards from the neighbourhood of the zygomatic arch of the temporal bone to the lower jaw. Their fixed point is above, and they therefore pull the lower jaw upwards, bringing the lower in contact with the upper teeth, while they can also produce a grinding movement of the lower on the upper teeth. Opposed to them is a number of muscles situated in the neck, chief of which is the **digastric**, so called because it consists of two slender muscular bellies which are united by an interposed tendon. The tendon is attached to the hyoid bone (H, Fig. 70), situated in the neck, to which one belly (1) passes from the base of the skull behind, while the anterior belly (2) passes upwards and forwards to the middle of the lower jaw-bone. When the muscle contracts it acts from its fixed point at the base of the skull, but the direction of action is changed by the attachment to the hyoid bone, which acts as a pulley, the lower jaw is therefore pulled down, and the mouth opened.

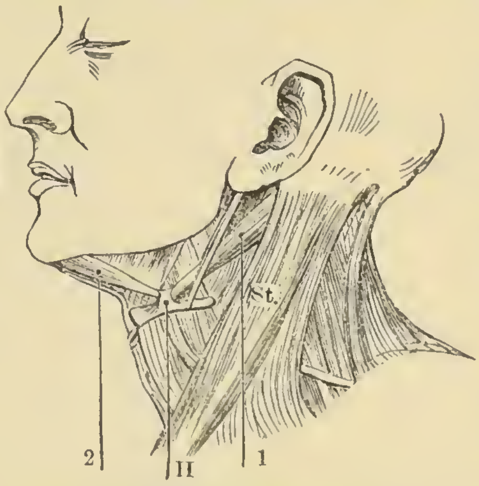


Fig. 70.—The Digastric Muscle.
1, Its posterior, 2, its anterior belly; H, hyoid bone; St., sterno-cleidomastoid muscle.

In the neck a large muscle passes from behind the ear down to the collar-bone in the neighbourhood of the breast-bone. When the neck is stretched, the projection of the muscle of each side can be easily made out, passing down obliquely near the middle line (St. Fig. 70). It is called the **sterno-cleidomastoid**, and by the contraction of the muscle of both sides the head is bent forwards. When the muscle of one side only acts, the head is inclined to that side, and slightly turned so that the face and chin look to the opposite side. It is by the spasmodic action of this muscle that wry-neck is produced.

The muscles of the eyeball are discussed in the section devoted to the consideration of the eye.

MUSCLES OF THE BACK.

A great number of muscles massed together lies all along the back from the neck to the hip on each side of the middle line, filling up the hollow between the back-bone and the most projecting parts of the ribs. Their function is chiefly to straighten the back after it has been bent. Two muscles, placed above them, may be mentioned particularly. The **latissimus dorsi** (Pl. X., *fig. 1*, 16), or broad muscle of the back, is attached to the spines of the lower half of the back-bone and to the crest of the hip-bone, and passes upwards over the lower corner of the shoulder-blade, towards the arm-pit, which it covers in behind, to be inserted into a groove near the head of the upper arm-bone. Its position is shown in the figure. The action of this muscle is readily understood. If the arm be elevated it will pull it downwards and backwards, and owing to the position of the groove of the arm-bone, in which it is fixed, it will also turn the arm so that the palm looks backwards, making the arm perform the movement described in swimming. If, however, the arm be raised and fixed, the muscle will pull the body upwards towards the arm, as when the trunk is pulled up by the arms in climbing. The **trapezius** (Pl. X., *fig. 1*, 6) covers the upper part of the back, and arises from a ridge on the occipital bone of the skull, and from the spines of some of the cervical and all the dorsal vertebræ. The fibres spread outwards so as to be inserted into the outer portion of the collar-bone and the spine of the shoulder-blade. The muscles of the two sides are so disposed as to form a sort of "tippet," covering the upper part of the back, and stretching outwards to the shoulders. The trapezius elevates the shoulder if it acts from the head as the fixed point. If, however, the shoulder be counted the fixed point, the head will be pulled back towards one side if the muscle of that side only contract, and if the muscle of both sides contract, the head is thrown backwards, the chin being projected forwards by the movement. *These are the two chief muscles that attach the trunk to the upper limbs behind.*

MUSCLES OF THE CHEST.

Some of the chest muscles will be more appropriately considered in the section on the respiratory system, since they are specially concerned in the act of breathing, and are therefore classified together under **muscles of respiration.** Under muscles of respiration is included the **diaphragm,** a muscle which forms an internal partition between the cavities of the chest and belly. Its action is also considered in the above-named section. Of the other muscles of the chest the chief are the **pectoralis major,** or larger chest muscle (Pl. X., *fig. 1*, 15), and the **pectoralis minor,** or smaller chest muscle, and the **serratus magnus.** The first rises partly from the anterior portion of the collar-bone, partly from the breast-bone, and partly from the cartilages of the ribs, and, passing in front of the arm-pit, is inserted into the side of the groove in the upper arm-bone. It is the opponent of the broad muscle of the back to this extent, that it draws the arm forwards, while it co-operates with the muscle of the back in pulling the limb down from the elevated position. If the arm be fixed in the elevated position, then it co-operates with the broad muscle in pulling the trunk up towards it. The **pectoralis minor** lies beneath the upper part of the major, and is inserted into the coracoid process of the shoulder-blade, which it depresses, thus opposing the trapezius. The **serratus magnus** muscle (Pl. X., *fig. 1*, 17) is in contact with the ribs in the upper and side part of the chest, rising by nine fleshy slips from eight upper ribs, and it stretches across to the shoulder-blade to which it is attached. If the ribs be fixed it pulls the shoulder-blade from the spinal column, and allows the arm to be farther outstretched; if the shoulder-blade be fixed, the serratus magnus, pulling from it, will raise the ribs. *These are the principal muscles that attach the trunk to the upper limbs in front.*

MUSCLES OF THE UPPER EXTREMITY.

The muscles that attach the upper extremity to the trunk in front and behind have already been sufficiently mentioned.

Muscles of the Shoulder.—The chief muscle of the shoulder is the **deltoid** (Pl. X., *fig. 1*, 8). It springs in front from the outer portion of the collar-bone, from the tip of the shoulder—the acromion process of the shoulder-blade,—as well as from the spine of the shoulder-blade, thus overlapping the most prominent part of the shoulder. From this it converges

THE MUSCLES OF THE HUMAN BODY.

THE ACTIONS OF THE MORE IMPORTANT MUSCLES ARE DESCRIBED IN THE TEXT — pp 113 [illegible]

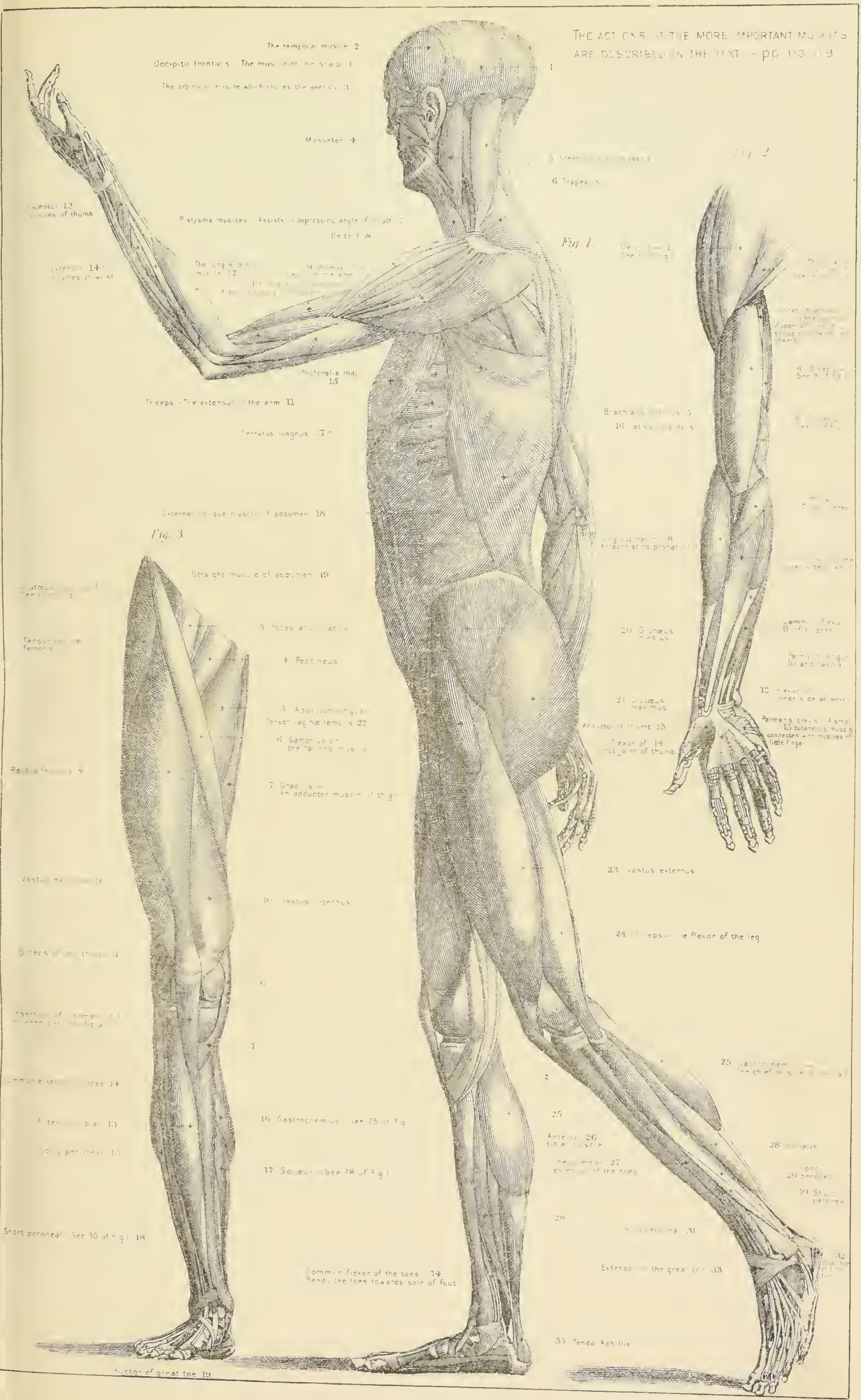


Fig. 1.

Fig. 2.

Fig. 3.

The temporal muscle 2
Occipito frontalis – The muscle of the scalp 1
The orbicular muscle which closes the eyelids 3
Masseter 4
5 Sterno [illegible] mastoid
6 Trapezius
Extensor 12 muscles of thumb
Platysma myoides Assists in depressing angle of mouth 7
Deltoid 8
Extensor 14 muscles of wrist
The long supinator muscle 12
9 Biceps [illegible] of the arm
10 [illegible]
Pectoralis maj 15
Triceps – The extensor of the arm 11
Serratus magnus 17
External oblique muscle of abdomen 18
Straight muscle of abdomen 19
Deltoid 1 See [illegible] 8
Brachialis anticus 3
16 Latissimus dorsi
Long supinator 8 Antagonist to pronator
20 Glutæus medius
21 Glutæus maximus
Abductor of thumb 13
Flexor of 14 first joint of thumb
23 Vastus externus
24 Biceps — the flexor of the leg
25 Gastrocnemius The chief muscle of the calf
25
Anterior 26 tibial muscle
The common 27 extensor of the toes
28
28 Soleus
Long 29 peroneal
30 Short peroneal
Short peroneal 31
32 Abductor of little toe
Extensor of the great toe 33
Common flexor of the toes 34 Bends the toes towards sole of foot
35 Tendo Achillis
Pectoralis [illegible] See [illegible]
Coraco-brachialis [illegible]
4 Biceps See 9 of Fig 1
Palmaris longus 10 and fascia
12 Flexor [illegible] inner side of wrist
Common flexor 11 of fingers
Palmaris brevis A small 15 cutaneous muscle connected with muscles of little finger
Glutæus [illegible]
Tensor vaginæ femoris
Rectus femoris 8
Vastus externus 9
Biceps of the thigh 11
Insertion of [illegible]
Common extensor of toes 14
Anterior tibial 13
Long peroneal 15
Short peroneal See 30 of Fig 1 18
Abductor of great toe 19
3 Psoas and iliacus
4 Pectineus
5 Adductor longus
Tensor vaginæ femoris 22
6 Sartorius or the tailor's muscle
7 Gracilis — An adductor muscle of thigh
10 Vastus internus
6
7
16 Gastrocnemius See 25 of Fig
17 Soleus See 28 of Fig 1
J. E. [illegible]

downwards over a third of the upper arm, till it is inserted into a rough surface on the outer side, and about the middle of the upper arm-bone. By its contraction the arm is raised from the side till it is at right angles with the trunk. For further elevation the action of the trapezius is necessary. Several other muscles pass to the shoulder from the upper and under surfaces of the shoulder-blade.

Muscles of the Arm.—They are classed together as either **flexors**, that is muscles that bend the arm through the medium of the elbow-joint, or **extensors**, muscles that straighten the elbow-joint. The main flexor is the **biceps** (Fig. 71, *a*), so called because it has two heads, one from the coracoid process of the shoulder-blade, the other from the upper edge of the socket in the shoulder-blade for the reception of the head of the arm-bone. Its tendon passes over the elbow-joint, and is inserted into a rough prominence near the head of the radius—the outer of the forearm bones. When this muscle contracts, the forearm is bent up on the upper arm, and if anything be held in the hand, heavy enough to offer resistance to this movement, then the muscle is seen standing out in front of the upper arm. (See Pl. I.) The chief opponent of the biceps is the **triceps** (Fig. 71, *b*), a muscle which arises by three heads, one of them from the shoulder-blade, the others from the arm-bone itself, whose tendon is inserted behind into the tip of the elbow, and whose action is to straighten or extend the elbow-joint.

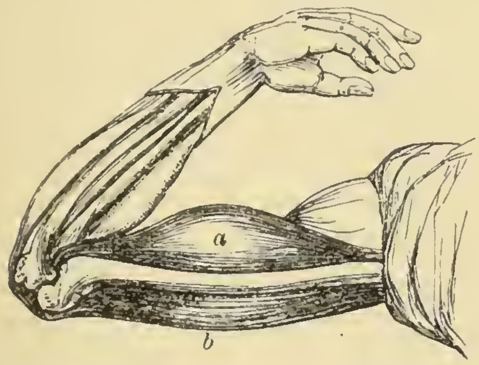


Fig. 71.—Muscles of Upper Arm. *a*, Biceps; *b*, Triceps.

Muscles of the Forearm.—The muscles of the forearm are divided into four classes:

I. **Flexors**, those which bend the hand at the wrist-joint and also bend the fingers, and II. their opponents the **extensors**, which straighten the hand and fingers, III. the **pronators**, which turn the radius (p. 62) and with it the hand, which it carries, palm downwards, and IV. their opponents, the **supinators**, which rotate the radius back again, and so turn the palm upwards.

I. All the **flexors** spring from the *inner* projection of the lower end of the upper arm-bone, and pass down *the front* of the arm. One set is devoted to bending the wrist-joint, one on the outer the other on the inner side, another set to bending the fingers. Of those that bend the fingers there is a superficial and a deep set, the superficial having four tendons, one for each finger, which are inserted into the second phalanx of each of the four fingers. The deep set has also four tendons which pass up the front of the fingers, pierce the superficial tendons, and pass on to be inserted in the base of the last phalanx of each finger. So that the tendons of the deep set bend the fingers at the first joint, those of the superficial set bend them at the second joint. The thumb has a separate flexor muscle. Fig. 72 (*b*) shows these arrangements.

II. On the *back* of the forearm and arising from the *outer* prominence or condyle of the upper arm-bone are the **extensor** muscles. There are extensors of the wrist and extensors of the fingers. The extensors of the wrist are three in number, two on the outer and one on the inner side. There is an extensor common to the four fingers having four tendons, one to each finger, which are attached to the first and second phalanges, and end upon the last phalanx, of each finger. The tendon of the ring finger is attached on one side to that of the little finger, and on the other to that of the middle finger, so that if the middle and little fingers are bent, the ring finger cannot be straightened, being held down by them. Fig. 72 (*a*). The thumb has three extensor muscles of its own, one attached to the base of its metacarpal bone, one to the first, and the other to the second phalanx. The first and second fingers have also special extensors of their own.

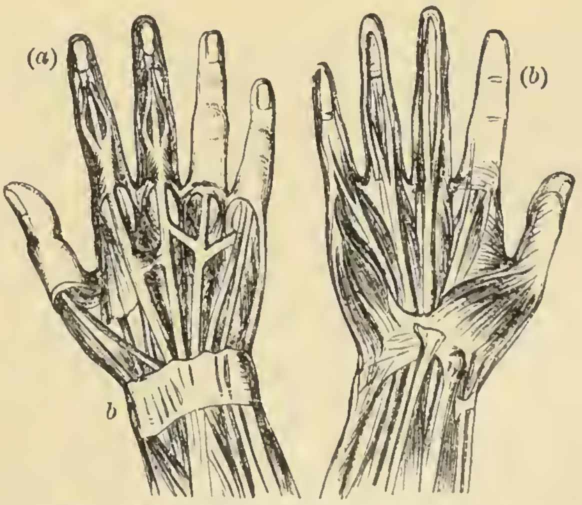


Fig. 72.—Muscles and Tendons (*a*) Back and (*b*) of Palm of Hand.

The tendons of the flexor and extensor muscles are bound down as they pass over the wrist into the hand by a strong band of fibres called the *annular* ligament, because it surrounds the wrist like a ring (see Fig. 72, *l*).

III. The chief **pronator** muscle is called **pronator radii teres**, and is in front of the arm and at the upper part (Pl. X., *fig. 2*, 7). It rises from the inner prominence of the arm-bone, and passes obliquely to be attached to the outer side of the radius about its middle. When it contracts it causes the radius to roll over the ulna, and as it carries the hand the palm is turned down.

IV. The **supinator** muscles are on the back of the forearm, and are so attached to the radius as to turn it back to its former position, making the hand turn palm upwards.

Muscles of the Hand.—Muscles lie in the spaces between the bones of the palm called **interossei** muscles. The thumb has a series of muscles, one for bending it, another for drawing it from the middle line, a third for approaching it to the middle line, and still another for opposing it to the other fingers. Similarly the little finger has its special flexor, its abductor and adductor muscles, as well as one for opposing it to the thumb.

MUSCLES OF THE ABDOMEN.

The walls of the abdomen or belly are formed mainly of muscles, which are in several layers, and are supplemented by fibrous sheets called aponeuroses. The muscles run an oblique course between the ribs above the crest of the hip-bone below. Low down in the line of the groin the aponeurosis is gathered together to form a broad band, called **Poupart's ligament**, which runs from the crest of the ilium to the projection of the pubis in front (p. 63). This ligament will be referred to in discussing rupture. A straight muscle runs down the front of the belly on each side of the middle line from the ribs to the pubis—the **rectus** (straight) muscle of the belly.

The abdominal muscles give support to the organs which they help to inclose. By their contractions, if the chest and pelvis are fixed, they can also press on the inclosed organs, and aid, for instance, in vomiting or in the expulsion of matters from the bowel or bladder. They can also draw down the ribs, or, if the back be not kept fixed, will bend the chest forwards; or, if the chest be fixed, they can draw up the pelvis, as in the action of climbing.

MUSCLES OF THE LOWER EXTREMITY.

Muscles of the Thigh.—In front of the thigh there are two muscles arising from the front of the back-bone in the lumbar region, and from the hollow of the haunch-bone. They pass over the edge of the pelvic bones to the thigh-bone, and become attached to the small trochanter of that bone, which, as already described (p. 63), is a prominence below the head of the thigh-bone directed inwards. They are called the **psoas** and **iliacus** muscles.

The office of these muscles is to **bend the hip-joint.** In other words, if we suppose their place of origin from the bodies of the vertebræ to be fixed, by their contraction they will bend the thigh up on the pelvis, or, if the attachment to the thigh-bone be fixed, if the leg be kept stationary, they will bend the body over the thigh. Opposed to the iliacus and psoas is the great mass of muscle that forms the buttocks. The mass is composed of several muscles which arise from the back of the haunch-bone, and are inserted by tendons into the thigh-bone in the neighbourhood of the great trochanter—the outer prominence of the thigh-bone. Thus, if the pelvis be fixed, the action of these muscles will **extend the hip-joint.** That is to say, suppose the thigh has been bent up on the pelvis, the muscles of the buttock will pull it down and bring it into line with the body. Suppose, however, the legs to be fixed and the body to be bent forwards, then the muscles will act from their attachment to the thigh-bone as the fixed point, and will straighten the trunk, restoring the erect posture. These muscles are, therefore, for this purpose largely developed in man. There are three muscles in particular which compose the mass of muscle referred to. They are called respectively **gluteus maximus** (Pl. X., *fig. 1*, 21), which forms the greatest prominence of the region, and whose margin forms the fold of the buttocks, the **gluteus medius** and **gluteus minimus** lying below the first, or the greatest, middle sized, and smallest glutei muscles. It is the largest of the three that is the chief extensor, the other two are also **abductors** of the thigh, that is, they draw the thigh away from the middle line. Associated with them is a number of smaller muscles that pass outwards and across from the pelvic bones to the thigh-bone, whose action is to turn the leg outwards. They are the **rotators outwards** of the thigh. They also support the hip-joint behind.

To oppose the abducting action of the smaller glutei muscles, there is a group of three muscles called **adductors**, namely, the **adductor magnus, longus**, and **brevis** (the great, long, and short adductors). They arise from the pubis, the front portion of the pelvic bones, and are attached to the thigh-bone, the first three uniting to occupy the whole rough line on the back of the bone. Being thus inserted at the back of the bone, they rotate it outwards while bringing it to the middle line, and they can also bend the thigh on the pelvis, or the pelvis on the thigh. These muscles are augmented by others which need not be particularized. To summarize, the muscles that pass between the pelvis and the thigh may be divided into the following groups:—I. **flexors**, passing over the hip-joint in front; II. **extensors**, placed in the region of the buttocks; III. **rotators outwards**, passing across between pelvis and femur behind; IV. **abductors**, also behind; V. **adductors**, in front and to the inside of the thigh.

There still remains a number of muscles attached to the thigh in front and behind. They are separated from the others by the fact that they pass beyond the thigh to become inserted below the knee-joint, and thus act principally on the knee-joint. They are divisible into two groups—I. **flexors of the knee-joint**, and II. **extensors of the knee-joint**.

I. The hamstring muscles are the **flexors**. They are three in number, and all arise from the prominence of the hip-bone (the tuberosity of the ischium) that forms the seat. One of them, called **biceps**, is attached to the head of the clasp-bone, the outer of the two bones of the leg, and is the outer of the hamstring muscles; the other two, **semitendinosus** and **semimembranosus**, are attached to the shin-bone on the inner side of the knee. When the three muscles act from the hip as their fixed point they will bend the knee-joint; and when the knee-joint is fixed they will extend the hip, that is, straighten the trunk. The **sartorius**, or tailor's muscle (Pl. X., *fig. 3*, 6), is a long, slender, ribbon-shaped muscle, which stretches from the upper projecting process of the hip in front across the front of the thigh to the inner side of the knee-joint, where it is attached to the shin-bone. It bends the hip and knee joints, at the same time directing the knee outwards, so producing the posture assumed by tailors. Hence its name.

The semitendinosus and sartorius muscles are also **rotators inwards** at the knee-joint.

II. **The extensor of the knee-joint** is properly one muscle, but divisible into four parts. It occupies the whole front and sides of the thigh. One distinct part is the **rectus**, or straight muscle, marked 8 on the Plate (fig. 3), which passes from the hip-bone straight down the front of the thigh till it ends in a broad, flat tendon, inserted into the upper surface of the knee-pan.

The lower edge of the knee-pan has another ligament which passes down to be inserted in front of the shin-bone, so that the rectus muscle is practically attached to the front of the tibia. The rectus is supported on each side by an extensive sheet of muscle, which is inserted into the same tendon, 12 of Plate (fig. 3). When this large extensor muscle acts from its attachment to the hip, it straightens the leg by extending the knee-joint. When the knee-joint is extended and fixed, the contraction of the muscle will flex the hip, that is, bend the trunk forwards.

Muscles of the Leg and Foot.—In the fore-leg the space between the shin and clasp bones in front of the leg is occupied by muscles which extend the foot. There is the **long extensor** of the toes, whose tendon runs over the back of the foot in four slips, one for each of the four outer toes. The tendon for the great toe is derived from a special muscle placed on the leg close to the long extensor. There is a third muscle (the **anterior tibial**) lying close against the tibia, whose tendon turns over the back of the foot at the instep to be inserted into the internal of the wedge-shaped bones of the tarsus. This is the muscle which raises the inner side of the foot, and spasm of which produces one form of club-foot. On the outer side of the leg is another muscle (the **third peroneal**), whose muscle turns over the outside of the foot in a manner similar to the foregoing. It raises the outer side of the foot; and spasm of it produces a second variety of club-foot.

On the outer aspect of the leg are two muscles (the **long** and **short peroneal**), whose tendons pass behind the external malleolus to be inserted, the former into the base of the metatarsal bone of the great toe, and the latter into the metatarsal bone of the little toe. They extend the foot and give it an outward direction, while they strengthen the arch of the foot.

On the back of the foot is the **short extensor of the toes**, whose tendons, one to each of the four inner toes, join those of the long extensor.

The arrangement of the extensor tendons of the toes is exactly similar to the arrangement of those of the fingers.

On the back of the leg there are two large muscles, **gastrocnemius** (Pl. X., *fig. 1*, 25) and **soleus**, which form the bulk of the calf of the leg. The former is the larger, and arises from the condyles of the thigh-bone; the latter is beneath it, and arises from the heads of tibia and fibula. Both are united in a common tendon, the thickest and strongest in the body, the **tendo Achillis**, so called from the old Greek fable, according to which Achilles was dipped by his mother into the River Styx, and so made invulnerable. He was held by this tendon, which, therefore, did not get immersed, and so remained capable of being wounded, the only vulnerable part of his body; and here he was in the end fatally wounded. The tendo Achillis is inserted into the back part of the projection of the heel-bone, the os calcis (Fig. 73). The two muscles, acting through the tendon, pull up the heel, and so raise the body on the toes. They are used in walking, jumping, &c. Beneath the calf muscles are the **long flexor of the toes** and the **special flexor muscle of the great toe.** The tendons pass behind the internal malleolus—the inner projection of the tibia at the ankle-joint—to reach the sole of the foot, where the long flexor divides into four slips, one for the end bone of each of the four outer toes. The tendon of the special flexor of the great toe proceeds to the last phalanx of that toe. In the sole of the foot itself is the **short flexor of the toes.** It arises from the heel-bone, and has four tendons, one for the second phalanx of each of the four outer toes. The tendons of the long flexor, in their passage to the last phalanges, pierce those of the short flexor. At the back of the leg, between the two bones, is the **posterior tibial** muscle, whose tendon passes beneath the internal malleolus to reach the scaphoid bone, to which it is attached. It extends the foot and gives it an inward direction. In the sole of the foot there are special muscles for bending, and directing outwards or inwards the great toe, and for bending and abducting the little toe, as in the hand for the thumb and little finger. Besides, there are **interossei** muscles, also, as in the hand, running between the metatarsal bones, arranged for moving the toes to one side or another.

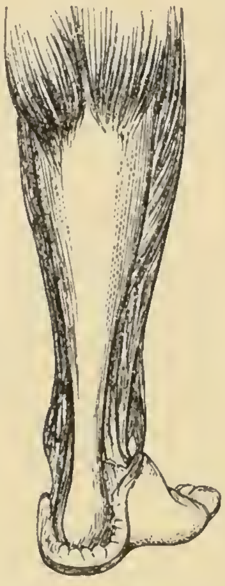


Fig. 73.—The Tendo Achillis.

In the sole of the foot a strong fibrous tissue, the **plantar fascia**, covers the muscles and extends from the heel-bone forward to the toes. It has a central and two side portions, the central portion being separated from the side portions by fibrous partitions which sink between the muscles deeply into the sole of the foot. When abscesses occur in the sole of the foot the plantar fascia confines the matter that is formed, and thus prevents it spreading. At the same time it prevents it working its way to the surface, so firmly does the fascia bind down the tissue. For this reason abscesses in the foot are often very troublesome to deal with, and very painful.

SYNOVIAL SHEATHS OR SACS

Tendon Sheaths.—It will be readily understood that the tendinous cords moving so frequently on the surfaces of bone, and over bony prominences, would be liable to develop friction and heat to an extent that might be injurious, unless some means existed for rendering the motion as easy as possible. This is effected by means of sheaths which surround tendons. The sheaths form a double lining round the tendons, and the opposed surfaces are lined by synovial membrane, already noticed as one of the structures entering into the formation of joints. The membrane secretes the fluid synovia, which lubricates the sheath in which the tendon slides, and so facilitates the motion. Such synovial sheaths are specially well marked in the tendons of the hand and foot.

In the case of the palm of the hand there are no less than five of such tubular canals or sheaths. There is one for the tendon of the thumb, which begins high up on the wrist and through which the tendon runs, till the last joint of the thumb is reached, where the sheath stops, and the tendon passes on to its fixed point. There is also one for the little finger, starting even higher up on the forearm than that of the thumb, passing through the palm of the hand and running right along the little finger till it ends at the base of the last joint. This sheath of the tendon of the little finger contains also the tendons of the index, middle, and ring fingers as far as the centre of the palm. Here these three fingers leave the common sheath, and pass on, each to its own finger, uncovered by a sheath. But when each of these three tendons reaches the base of its own finger, it enters a sheath of its own, which extends over the front part of the first two bones of the finger, and ends at the base of the end bone of the finger. The tendons that run on the back of the hand are similarly clothed with synovial sheaths, but only for a short distance. On the back, the sheaths are situated over the wrist, extending only a little way above over the fore-arm, and below over the back of the hand. At this place all the tendons are bound down by a broad band of ligament, which crosses from one side of the wrist to the other. The tendons pass, side by side, underneath this band, and the sheaths form tunnels, as it were, under the band for the passage of the tendons.

If these sheaths become inflamed, an increased quantity of the fluid—synovia—they secrete will be produced, and will distend the sheath, and will produce an appearance on the front or back of the wrist, of a narrow, elongated, swelling, somewhat sausage-shaped. The wrist will be more or less deformed by these soft swellings under the skin. This is a frequent occurrence in chronic rheumatism of the hands or feet. For it is the rheumatic poison that most frequently produces such sheath inflammations, and that is the reason for the term **chronic synovial rheumatism**. But the inflammation may be confined to one sheath, perhaps due to an excessive amount of movement or strain on the particular tendon whose sheath it is. This is not an infrequent occurrence on the wrist of pianists or violinists, and one variety of it causes the round swelling, in shape like a boy's marble, on the back or front of the wrist (see Ganglion, p. 122).

There is a very similar arrangement of tendon sheaths on the back and sides of the foot, the sheaths being distributed over the back of the ankle, and on each side at the junction of foot and leg. In the sole of the foot the arrangement resembles the palm of the hand.

Synovial Sacs or Bursæ.—Besides sheaths lined with synovial membrane, little sacs similarly lined, and containing fluid, exist in special places between two surfaces which move upon one another to any great extent. Such sacs are called **synovial sacs**, or **synovial bursæ**, or simply **bursæ**. Bursa means a sac.

For instance, the movement of the knee-pan in front of the knee-joint has been already referred to. This motion, so constant in walking, would be sure to produce undue friction and heat, and consequent inflammation, were it not for the interposition of such a sac between the upper surface of the joint and the deep surface of the knee-pan.

Again, the knee-pan moves underneath the skin, and, to prevent friction between its upper surface and the skin, another synovial sac or bursa is interposed. So that the knee-pan is between two bursæ, one superficial, just under the skin, the other deep beneath the bone. When these are inflamed, as they may be by injury, the large amount of increased secretion into the sacs distends the skin in every direction, and causes all the usual outlines of the joint to be lost. The knee-pan is thrust forward and seems to be floating on the surface of a bay of fluid, unless the bursa in front of the knee-pan is also involved, when the bone comes to lie between two sacs distended with fluid.

Similar, though smaller, sacs are found over the point of the elbow, over the knuckles, over the malleoli—the outer and inner projections of the ankle-joint,—and over various other prominent points, the great trochanter of the thigh-bone, for example. They may also be present between two tendons or two muscles.

It is important to notice the bursæ, as they fulfil a very important duty, and are besides liable to disease, and specially to various forms of inflammation.

SECTION V.

THE MUSCLES, TENDONS, AND BURSÆ.

THEIR DISEASES AND INJURIES.

Diseases of Muscle:
Wasting and Overgrowth (Atrophy and Hypertrophy).
Muscular Spasm—Cramp.
Bather's, Writer's, Pianist's Cramp—Stiff-neck—Wry-neck.

Diseases of Tendons and Bursæ:
Simple Inflammation;
Whitlow;

Diseases of Tendons and Bursæ (*Continued*):
Ganglion;
Enlargement of Bursæ—Housemaid's Knee—Miner's or Student's Elbow: Tennis Elbow.
Bunion.

Injuries of Muscle and Tendon:
Rupture;
Sprain.

DISEASES OF MUSCLE.

WASTING AND OVERGROWTH
(*Atrophy and Hypertrophy*).

Wasting (*atrophy*, Greek *a*, not, and *trepho*, I nourish) may arise in muscle from changes in the nourishment of the part, from want of exercise, or from a nervous disease. Thus an arm that has been kept up for some weeks in splints because of fracture will, when unbound, be found very much thinner and weaker than its neighbour, owing to the enforced want of exercise. Sometimes, after a fever, cold, or other disease, one arm or leg or both legs become chilly, benumbed, and thin, and, in the case of children, cease growing in proportion to the rest of the body. An injury to an arm or leg, involving a nerve of the limb, may lead to wasting of the muscles to which the nerve proceeds. There is a disease of the spinal cord which causes rapid wasting. (See Progressive Muscular Atrophy under DISEASES OF THE NERVOUS SYSTEM.)

Treatment.—Good food and exercise and the use of quinine and iron and similar tonics are the general remedies ordered for muscular wasting. Rubbing the affected parts with stimulating liniments, such as the liniment of camphor and ammonia (see APPENDIX OF PRESCRIPTIONS) is of value. Massage, Swedish movements, and electrical treatment are important.

Overgrowth (*hypertrophy*, Greek *huper*, beyond what is usual, and *trepho*, I nourish) is a condition of increased nutrition. The arm of the blacksmith, for example, has muscles which exhibit greater growth than usual, owing to the stimulus of exercise; and this is quite natural.

In children there sometimes occurs a nervous disease which produces apparent increased growth of muscle, particularly of the buttocks and back of the legs. The increase is only apparent, however, so far as the muscles are concerned. They are actually wasted, and the increased bulk is of fat and connective tissue. Weakness is a marked symptom of the disease, paralysis ensues, and death results.

Electricity is the only remedy that seems of advantage. (See Pseudo-Hypertrophic Paralysis, under DISEASES OF THE NERVOUS SYSTEM.)

MUSCULAR SPASM—CRAMP.

Cramp.—By this is meant the spasmodic and involuntary contractions of the muscles of the body, either those which are under the control of the will or *voluntary* muscles, or those which are not subject to the will, the *involuntary* muscles. As an example of cramp in the voluntary muscles may be taken those severe pains experienced in the legs, feet, hands, and fingers; and of cramp in the involuntary muscles, cramp of the stomach and of the bowels (colic) may be taken as examples. Cramp is attended by rigidity and pain, and usually passes off in a brief space of time. It may be a mere symptom in the course of some other disease, for example in cholera; and is liable to arise when the general health is affected by indigestion, rheumatism, gout, bloodlessness, pregnancy, &c.

While it may occur in any muscle, it is most common in the muscles of the calf of the leg. There are some persons who are peculiarly subject to cramp, a certain position of the limbs, for example crossing the legs, being sufficient to induce it. Many fatal accidents have occurred to bathers from their being seized with cramp of the limbs. The attack has a sudden onset, is accompanied by a rigid state of the muscle and severe pain, and is usually of a few minutes' duration, though it may last for several hours.

Treatment.—An endeavour must be made to *prevent* attacks of cramp by due care as regards the diet, and proper regulation of the bowels. To regulate the bowels, small doses of rhubarb with bicarbonate of soda (baking-soda) will be found very efficient, the former being given in doses of 8 to 10, the latter in doses of 12 to 20 grains.

When the attack is due to some general disease, such as those already mentioned, that general disease must be treated.

During an attack of cramp the affected limb should be firmly grasped, forcibly straightened, and rubbed with the hands. If friction prove unsuccessful, the part should be put in hot water and afterwards diligently rubbed with a liniment of soap and opium, chloroform, or laudanum. *Cramp in the stomach* is usually caused by the presence of some undigested article of food, and is a common symptom in *indigestion*. For its treatment, see DISEASES OF THE STOMACH.

Bather's Cramp.—Many fatal accidents have occurred to bathers from their being seized with cramp in the limbs. Sometimes the spasm may seize almost all the voluntary muscles, and render it impossible for even the most expert and cool-headed swimmer to save himself. The cause seems to be the sudden shock of cold applied to the body. It occurs most readily when the body is very warm, and in vigorous persons after prolonged muscular exertion. Thus swimming with great vigour and rapidity, and with great exertion of the arms and legs, may determine its occurrence. These conditions ought, therefore, to be avoided; and, in particular, *none should suddenly plunge into cold water while the body is unduly heated.*

A person seized with cramp, who has been taken out of the water, should be placed in warm blankets, surrounded by warm bottles, and rubbed. A most useful treatment would be to place him at once wholly in a bath of warm water, the head only being supported out of the water.

Writer's Cramp affects those whose business compels them to write continuously for many hours. Whenever the person engages in writing, spasm of the muscles being used comes on, causing jerky movements or stopping motion altogether. It is probably due to over-exertion and fatigue of the muscles. Pianists sometimes suffer from a similar affection of the muscles used in their vocation, **Pianist's Cramp.** Absolute rest from the habitual motions is necessary. Tonic treatment, friction to the part with liniments, and the use of electricity have benefited, but the disease is very intractable.

Stiff-neck is the commonest example of cramp. It is partly rheumatic and partly inflammatory, and is commonly due to cold. The application of hot cloths and the use of gentle rubbing will probably be sufficient to relieve it.

Wry-neck is usually caused by spasm of the sterno-mastoid muscle of one side, by which the head is pulled down to that side and turned so that the face and chin are directed to the opposite shoulder. If it is due to inflammation, heat and pain will be present. In acute cases purgative medicines should be given, and hot poultices or cloths should be applied over the muscle, the person lying at rest. Good diet and tonic medicines are also required. It may only be an evidence of disease elsewhere, such as tubercular disease of the spinal column, the nerve to the muscle being involved. In chronic cases a weak constant current of electricity passed through the muscle is of value. Division of the nerve supplying the muscle is sometimes the only cure.

DISEASES OF TENDONS AND BURSÆ.

Simple Inflammation is liable to attack tendons as the result of a sprain, or owing to gout or rheumatism, their synovial sheaths being also attacked.

The disease may be manifested only by wearing rheumatic pains, accompanied, in some cases, by a creaking feeling when the tendons are moved, and a sound like the rustling of silk. In more acute forms, and specially as the result of injury, considerable swelling may occur, and the overlying skin is hot and reddened.

Rest to the part and painting with tincture of iodine will do much to relieve the patient. In the acute cases warm fomentations should be employed.

Whitlow is a severe form of inflammation which attacks the tendons of the fingers. It begins near the point of the finger in front, which is exquisitely tender, red, swollen, and hard. The pain, which is severe and throbbing, spreads often up the arm to the shoulder. The inflammation may run rapidly along the finger in the tendinous sheath, specially if matter forms in the sheath and cannot get a way of escape externally. If it is allowed to progress, the whole hand, and even the forearm, may become affected, the joints and bones also being seriously imperilled.

Treatment.—Brisk purgatives of salts or seidlitz should be given to the patient, and leeches followed by hot fomentations applied to the part, the hand being kept at rest in an elevated position. *But it is usually necessary to make a free incision along the centre of the finger down to the bone, to let matter escape.* It sometimes requires most energetic steps on the part of a skilled surgeon to save the finger, and sometimes to save life, which an aggravated case will occasionally threaten. Disfigurement often results. The patient's strength requires to be properly supported by foods and tonics of bark, iron, &c.

Ganglion (Scotch, *lippen sinen*) is a swelling at some place in the course of a tendon, due to irritation of the sheath of the tendon, and the consequent outpouring into the sheath of more than the usual amount of lubricating fluid and inflammatory material. As a result there is formed a small, firm, and movable swelling, which grows slowly, and is found to contain a firm, clear, jelly-like substance, originally fluid. The swelling is most common on the back of the wrist, and less frequently on the back of the foot. Occasionally bodies like melon or rice seeds are formed in the sac from the inflammatory deposit.

The proper **treatment** is either to burst the tumour by pressure and squeeze out the gelatinous substance or to open the sac with a knife. A rough but efficacious method of treating ganglion of the wrist is to cause the patient to lay his hand on the knee of the person who is going to burst the ganglion. Cover the hand with a towel. Then let the operator take a heavy book and bring it down heavily upon the hand. This will burst the sac. After removal of its contents pressure should be exerted on the sac to prevent the return of the swelling. The hard top from the cork of a lemonade bottle rolled in a small piece of lint and bandaged firmly over the part is a simple way of effecting this. Painting with iodine is used for the same purpose, or a small blister may be applied.

ENLARGEMENT OF BURSÆ.

It has been pointed out (p. 119) that synovial sacs occur between bony prominences and the skin to prevent undue pressure. In the case of the knee-pan there is a sac both between it and the skin and between it and the knee-joint. The bursa in front of the knee-pan is particularly liable to swelling in those who kneel much, and forms housemaid's knee.

Housemaid's Knee.—This may be an acute disease accompanied by severe pain, much swelling, and inability to move the joint. As a result of the inflammation matter may be formed and an abscess developed. In the chronic form, permanent swelling, through the fluid not being absorbed, and stiffness, may be the only trouble. *Housemaid's knee is to be distinguished from inflammation and dropsy of the knee-joint* by the fact that when the disease is in the joint the knee-pan is forced forwards and can easily be felt under the skin, while in housemaid's knee it is the sac *in front of* the knee-pan, not the joint, that is affected, and the knee-pan is therefore masked, and cannot be felt owing to the swelling in front of it.

Treatment.—The acute form demands rest, a pillow being placed under the joint to support it. In the early stages leeches will relieve the inflammation, and later hot cloths or poultices are valuable. To aid in reducing the inflammation a purgative of salts or seidlitz should be given to the patient. If an abscess forms it ought to be opened to let the matter escape, and the wound ought to be dressed afterwards with carbolic lotion (1 of acid to 60 of water), a small pledget of lint, soaked in the lotion, being thrust between the lips of the wound to permit free escape to any matter that may form later. When the affection is chronic, blisters and iodine paint are employed. The application of a starch or plaster bandage over a layer of stimulating ointment is very successful.

Miner's Elbow.—A similar affection, from pressure or injury, may attack the bursa over the point of the elbow, or the bursa which lies between the prominence of the hip-bone, that supports the body in the sitting posture and the muscles above it. The swelling over the point of the elbow is often seen in miners and students, and is if heeded called **miner's** or **student's elbow**.

The treatment is the same for all.

Bunion is an inflammation and enlargement of the bursa at the side and in the neighbourhood of the ball of the great toe. The irritation is frequently so severe as to cause contraction of the muscles attached to the toe, producing displacement and deformity. The irritation, if aggravated by the pressure of badly-made boots, may be so severe and long-continued as to produce disease of the joint and bone.

Treatment.—First of all let properly-made boots be obtained. Place a soft pad of wool between toes that overlap, and renew it daily. A contrivance of rubber for the purpose may be obtained from a bootmaker.

Soothe the irritated bursa by rest and hot applications; let a bunion plaster be worn to protect the bursa from pressure. The bunion plaster is made of a pad of cotton-wool, with a hole in the centre to admit the bunion, and attached to an oval piece of adhesive plaster. Bunion protectors of rubber are also made.

Immense relief can be given by an operation for removing the diseased bursa and the overgrowth on the bone which is usually present.

INJURIES OF MUSCLE AND TENDON.

Rupture or tear of muscle or tendon is due to violent muscular contractions. The muscles most liable are the large muscle of the calf of the leg (*gastrocnemius*), the *biceps* of the arm, and the straight (*rectus*) muscle of the thigh that joins the knee-pan. The tendons give way more frequently, particularly the *tendo Achillis* attached to the heel, and the tendons that bend the wrist.

Tennis Elbow is a variety.

The **symptoms** are sudden pain at the place of tear, accompanied often by an audible snap, and loss of power. A hollow may be detected at the seat of rupture.

Treatment.—The ends of the ruptured muscular fibre or tendon are reunited by a process of repair, by which a new tissue is formed between them. In order to permit this to take place rest is absolutely necessary; and to permit the ends to be brought as near to one another as possible that part should be fixed so that the injured muscle or tendon is relaxed. Thus, let the knee be kept bent when the calf of the leg or tendo Achillis is involved; let the leg be raised and straightened as for fractured knee-pan when the rectus muscle of the thigh is injured. If the biceps of the arm be ruptured bend the elbow, and so on.

Retain the part in its proper position by padded splints and bandages for three or four weeks. After that let the joints of the injured limb be gently exercised, and let great care be taken for a considerable time to prevent renewed rupture or stretching of the new tissue which joins the severed ends.

The most perfect method of treatment, however, is for a surgeon to cut down on the torn ends and stitch them closely together, the limb being afterwards fixed in a splint.

Sprain is violent stretching of tendon or ligaments of joints, and is often accompanied by partial tearing. The ankle-joint is often affected by the foot being caused to double up under the person.

Symptoms.—There is pain on moving the part, swelling, greater or less according to the degree of injury, and perhaps discoloration. If it be not attended to, severe inflammation may arise and fever ensue, especially if a joint is affected. After the inflammation and pain have passed off, some degree of stiffness will remain and weakness may be permanent.

Treatment.—Absolute rest is necessary. If the knee or ankle joints be affected splints ought to be applied to maintain rest, and nothing is better than after careful washing and drying to pad the part with wool and fix by a plaster-of-Paris bandage. In the case of the knee the splint should be behind; but if inflammation ensues the easiest position will be found to be with the knee slightly bent and supported on a pillow. Warm fomentations should be applied. If the pain and heat are great leeches are valuable. When all inflammation has passed let the joints be gently exercised by hand and rubbed with a liniment of soap and opium. Good will also be derived from the employment of the hot and cold douche alternately. For some time afterwards the limb must not be too freely used lest the swelling and pain return.

SECTION VI.

ORGANS OF MOTION AND LOCOMOTION.

THEIR FUNCTIONS (PHYSIOLOGY).

Levers—
Their Classes and Illustrations in the Body.
Standing.
Walking.
Running.

The active agents of movement in the body are the muscles, which, by their contraction, cause the bones to move one on the other, the motion being permitted owing to the union of bones to one another being accomplished through the medium of joints. Of course if all the bones were *rigidly* connected with one another all movements would be impossible. Now, the muscles, bones, and joints are related to one another in different ways in order to make the movements more effective for different purposes. The bones form **levers**, the attached muscles supplying the **power** for moving them, the joints being the **fulcrum**, or point of support, while the **resistance** is supplied by the weight of the limb, the weight to be lifted, or the force to be overcome. In mechanics there are three orders of levers described, according to the relative positions of power, fulcrum, and resistance; and it is found that all the movements of bones on one another can be referred to one or other of the three orders of levers.

Fig. 74 shows a **lever of the first order**, where the fulcrum (F) is between the weight to be lifted (W) and the power (P). There are several examples of this kind of lever in the human body. The head supported on the atlas is a good example. The joint between atlas and skull (p. 61) is the fulcrum, the resistance is the weight due to the part of the head and face in front of the joint, which tend to produce falling down of the chin on the chest, and the power is behind, where the muscles from the neck are attached to the back of the skull. The effect of this particular arrangement is to keep the head steady, balanced on the back-bone, and it is easily seen how well adapted this kind of lever is for such a balancing purpose. It is therefore called the **lever of stability**. The back-bone is balanced on the haunch-bones, and the leg is balanced on the foot, by a similar arrangement, the hip-joint in the former case, and the ankle-joint in the latter, being fulcrum. This lever is also used in the body more directly to effect movement. When the forearm is straightened on the arm the elbow-joint is fulcrum, the power is supplied by the triceps muscle *behind*, and the resistance is the weight of the forearm *in front* of the fulcrum (Fig. 75).

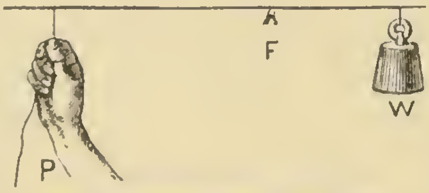


Fig. 74.—Lever of the First Order.

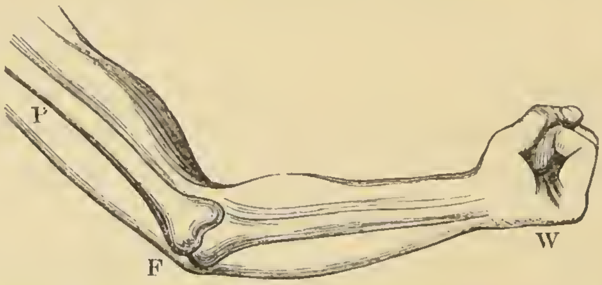


Fig. 75.—Lever of the First Order, illustrated by straightening of the Elbow-joint.

In **levers of the second order** the weight is between the power and fulcrum (Fig. 76). It is not common in the body. Standing on tiptoe, however, is an example. The fulcrum is afforded by the toes, in contact with the ground; the power is the action of the muscles of the calf, and between these is the weight of the body transmitted down the bones of the leg to the foot (Fig. 77).

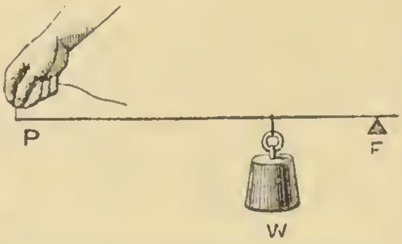


Fig. 76.—Lever of the Second Order.

In levers the force exerted is always proportional to the distance between the fulcrum and the point of application of the force. Now, in levers of the second order the distance between the power and the fulcrum—called the **power arm**—is greater than the distance between the weight and the fulcrum—the **weight arm**. So that a force acting through the greater distance between the power and fulcrum would be able to *overcome* the same force acting through the smaller distance between the weight and fulcrum, just because, though the forces were the same, the power arm was longer than the resistance arm. In other words, a smaller power would be able to overcome a larger resistance, because of its greater distance from the fulcrum. This lever is therefore called the **lever of power**. This lever has the disadvantage that the power must always move through a greater distance than the weight.

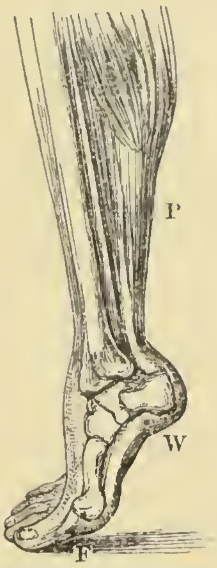


Fig. 77.—Lever of Second Order, illustrated by standing on tiptoe.

In **levers of the third order** the power is between the weight and the fulcrum (Fig. 78). It is common in the human body. In bending the forearm on the arm the power is supplied by the biceps muscle attached to the radius, the fulcrum is the joint at one end of the lever, and the weight is at the other end—the weight of the forearm (Plate I).

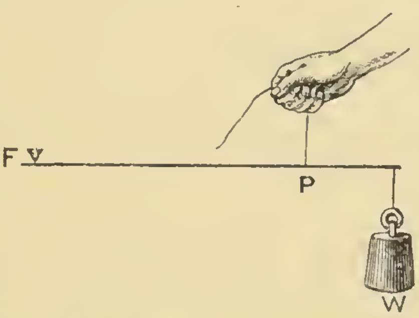


Fig. 78.—Lever of the Third Order.

It will be remembered that at the elbow-joint an illustration of a lever of the first order also is afforded *in the extension* of the joint by the triceps muscle.

This is the **lever of rapidity**, for it will be observed that a small movement of the biceps will produce considerable movement of the hand. It is, however, a lever that loses power, for, unlike the last case, here the weight arm is long and the power arm short.

ANIMAL MECHANICS.

Standing in the erect posture is the position which requires least muscular exertion, the different curves of the back-bone aiding in balancing the trunk, and the various joints being so constructed that only a certain amount of steadying action is required on the part of the muscles, the muscles of the calf, for instance, preventing the falling forward of the leg. In the erect posture, too, the body fulfils the necessary condition of having its centre of gravity within its base of support. Thus, a line dropped from the centre of gravity, which is in front of the sacrum, would fall between the feet a little way in front of the ankle-joints.

Walking.—The weight of the body is supported alternately by one limb and then the other, being hardly balanced on one limb before it is thrown to the other. At the moment when the advanced foot has reached the ground the muscles of the calf of the leg behind contract and raise the body on the ball of the toes (Fig. 77), thrusting it forwards and to the side. The weight of the body is thus thrown on the advanced leg, and, owing to the forward movement, the leg that is behind swings forwards like a pendulum, and now becomes the advanced leg, and so the process goes on.

Running.—For a short period both feet are off the ground. Running differs from walking also in the quick violent contractions of the muscles, and in the fact that the advance is due to muscular effort alone, and therefore there is proportionately a much greater expenditure of force than in walking.

Thus motion and locomotion are dependent upon mechanical relations subsisting between muscles, bones, and joints. When these relations are interfered with there is difficulty of movement greater or less according to the amount of the interference, as will be seen by considering the diseases of movement in the following section.

SECTION VII.

DISEASES OF MOTION AND LOCOMOTION.

Rigidity:—*Anchylosis*—*Contracted Muscles or Tendons.*

Deformities:—*Club-foot*—talipes varus, valgus, equinus, calcaneus;
Flat-foot;
Knock-knee;
Bow-legs;
Clubbed Hands;
Supernumerary Fingers and Toes.

RIGIDITY OR STIFFNESS OF JOINTS.

It has been pointed out that a joint usually acts as the fulcrum or fixed point from which the bony lever operates when moved by muscular contraction. If, therefore, from any cause the joint has become so stiff as to be immovable, the function of the parts is destroyed. Now, the stiffness may either be due to disease of the joint itself, or it may be caused by fixture of the joint by contracted muscles or tendons in its neighbourhood.

Anchylosis (from Greek *ankulos*, crooked) is the term applied to rigidity that has resulted usually from inflammatory disease of the joint. It may occur, without inflammation, in a joint which has been kept in one position for a long time, and in old age it occurs as a natural process in certain of the smaller joints. Anchylosis has been divided into *true* or *false*, or *complete* and *incomplete*. **True anchylosis**, or stiffness or immobility of the joint, is said to exist when the gristle of the joint is destroyed and the heads of the bones are connected or consolidated together by osseous or bony matter (p. 74). **False anchylosis** is where the process falls short of ossification, the stiffness and immobility depending not on bony union of the connecting surfaces, but either upon adhesions of the synovial membrane or upon a thickening of the parts about the joint.

When the gristle of a joint has been destroyed by ulceration, and the surfaces of bone exposed, anchylosis, or a bony union, is the most favourable termination that can take place. In such a case care should be taken that the joint becomes fixed in the position in which it will be most useful to the patient. Thus, if it be the hip or knee, the straight position will be best; if the elbow, it should be placed at a right angle. Again, in scrofulous ulceration of the spine, anchylosis is a most favourable result, because as soon as the bony union is formed the morbid or diseased process is ended, and it is the completion of the cure. Thus in hip-joint disease, white swelling, and scrofulous (tubercular) diseases of the spine, anchylosis is often to be regarded as a favourable issue.

Anchylosis, however, in fractures near the joints, should always be prevented if possible; and for this purpose, gentle motion of the joint ought to be had recourse to before it is too late, as directed in the section on Fractures.

In cases of *incomplete anchylosis*, where the stiffness only arises from thickening of the parts, much relief may be derived from the use of steam, by placing the stiff joint over the steam of boiling water, at such a distance as to prevent scalding, then drying the part, and rubbing it with neat's-foot or cod-liver oil, or the compound soap liniment, or goose fat. By perseverance in this plan of treatment complete restoration of function may be obtained. Cold applications, such as holding the part below a rush of water, or pouring water from a tea-kettle, have likewise been employed; and when the patient has arrived at middle life, this may be used twice a day, and the part dried, and some of the above liniments rubbed on. The flow of cold water should, however, not be used longer than three or four minutes, as no good will be effected unless a glow of heat is felt in the part after it has been dried.

Surgeons now practise an operation for breaking up the adhesions in cases of false anchylosis, and so restoring the natural movements of the joint.

Contracted Muscles or Tendons may render a joint immovable. Sometimes the contraction of a muscle is *spasmodic*, as in spasmodic wry-neck, discussed in the last section. In other cases the contraction of one set of muscles is *due to paralysis of the opposing set.*

Thus suppose, as in some cases in children due to a nervous affection, that the muscles in front that straighten the leg on the knee have become paralysed, the flexor or hamstring muscles behind will have it all their own way, and will keep the knee bent, so that the child cannot of its own will extend the leg. *Early in the disease*, however, a person taking the child's leg in his hand will be able easily to straighten it; but, as soon as he lets it go, it will spring back to its bent position. When the disease has *become confirmed* the flexor muscles tend to become permanently rigid in their shortened condition, the child never being able to put them on the stretch by straightening the leg. So that, after a time, neither the child nor another person can extend the leg, which remains fixed in its distorted position.

Such deformities of limbs are of not infrequent occurrence in children, and many, if not the most of them, are easily rectified *if early attended to.* It is difficult sometimes to say whether the deformity is due simply to *spasm* of one muscle or set of muscles, or to *paralysis* of one set, and consequent shortening of the opposing muscles. The advice of a skilled surgeon should, therefore, be sought to determine this as well as the treatment; for in some cases cutting of the rigid muscles will be necessary, while in others the remedy is to be sought for rather in restoring power to the paralysed muscles.

CLUB-FOOT AND OTHER SIMILAR DEFORMITIES.

Club-foot, the scientific name of which is **Talipes,** is a deformity of the foot due to shortening and stiffness of certain muscles and tendons, and accompanying alterations in the position of the tarsal bones and in the form of their joints. Owing to the deformity the person cannot put the foot down on the ground in the usual way, resting on the sole. The foot is so twisted that the person walks on the outside edge of the foot, or on the inside edge, on the heel only or toes only. There are thus several varieties of club-foot, according to the way in which the foot is twisted.

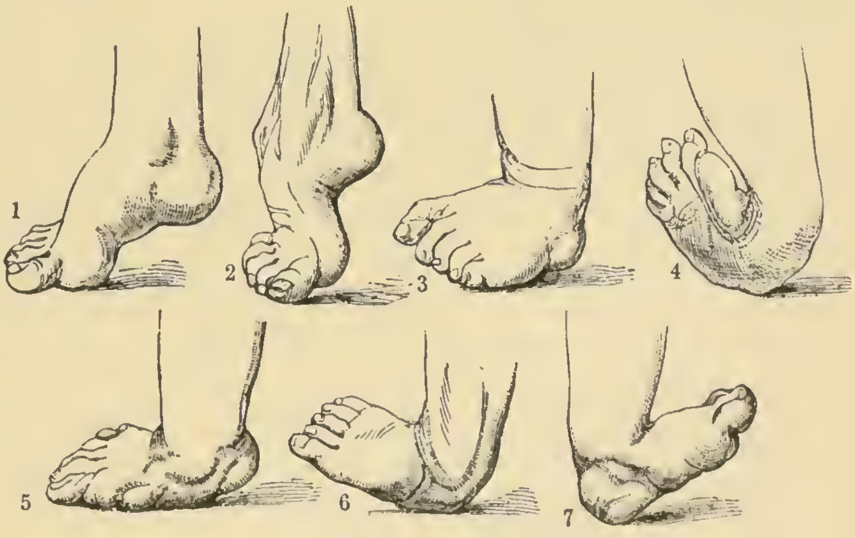


Fig. 79.—Talipes.
1 and 2, Equinus; 3 and 4, Varus; 5 and 6, Valgus 7, Calcaneus.

Four general forms are described: (1) in which the *outer* edge rests more or less on the ground, the inner edge being turned upwards—**talipes varus**; (2), in which the *inner* edge rests on the ground, the reverse of (1)—**talipes valgus**; (3), in which the heel is raised and only the toes touch the ground, called **talipes equinus** (Latin *equus*, a horse), because of its resemblance to a horse's hoof; and (4), in which the reverse is the position, the front portion of the foot being raised, and only the heel reaching the ground—**talipes calcaneus.** Besides these there may be other kinds in which there is a combination of two of the different forms described.

All of these forms of club-foot may be *congenital*, that is, the child may be born with the deformity, or *acquired*, that is, the affection may be developed after birth. In both cases the disease may be caused by *paralysis* of muscles or by *spasm.* Thus take the case of club-foot where the outside of the foot is turned down and the inside up. On referring to the section on the Muscles it will be seen that the muscles that pass from the leg to the outer side of the foot are the peroneals, and that they raise the outer side, while on the inner side the foot is raised by the tibialis anticus. Suppose the peroneal muscles become paralysed, then the foot cannot be raised on the outer side, and there is nothing to oppose the action of the tibialis anticus, which accordingly pulls up the inner side, and so the deformity is produced. But again, the tibialis muscle may become spasmodically contracted, and by the force of its spasm overcome the action of the healthy peroneal muscles, and so turn the inside of the foot up, producing a like deformity. Similar causes are at work in the production of the other kinds of club-foot.

If the child has been born with the feet in a natural position, and the deformity has come on at some later period of life, the probability is that paralysis is the cause of it, paralysis affecting groups of muscles only, leaving other muscles unaffected. The disease in which, or rather as one result of which, this deformity very often develops, is a disease of the spinal cord, called Infantile Paralysis of Children (see p. 179). This disease may attack children so insidiously that attention is not seriously called to it till grave mischief has been done and perfect recovery imperilled. This is specially likely to occur in children who have not yet begun to walk. In children who are already old enough to walk, the disease is speedily called attention to, for one of its first results is to paralyse one or both of the child's legs, and sudden inability to stand or walk calls immediate attention to the child's condition. In the case of a child, therefore, who has not yet begun to walk, a physician should be consulted without delay, if a notable change is observed in one or both feet, altering the way in which they hang, toes pointing downwards, for instance, or the sole markedly being turned outwards or inwards. A great deal may be lost by neglect to seek advice *early*, both because the true nature of the disease, causing the deformity, may be discovered in time to prevent so much mischief occurring, as would likely ensue if the disease were overlooked, and also because the earlier the deformity itself is treated the better.

If the defect has existed from birth, its treatment is more hopeful than if it has been the result of subsequent paralysis. Indeed if treatment is begun soon enough, and is patiently carried through, perfect recovery should be obtained.

Treatment.—In all cases two things require to be done The first is, by manipulation to bring the foot into its proper position, and the second is to keep it there.

When the child has been born with the defect, this treatment should be begun immediately. In such a case, then, let the mother or nurse take the foot in the hand, and gently and gradually bring it back to its proper position, retaining it there for a little time. It may not, at first, be possible to bring it quite straight. Let the process be repeated often, but only for a few minutes each time, the muscles of the leg being stroked and handled frequently. It will probably be found that the foot in time can be made quite straight with ease. When this has been accomplished, some apparatus may be adapted for the purpose of supporting the foot in the proper position. A plaster-of-Paris bandage would probably be the best for this purpose, but it must be applied to the foot already thoroughly bent round into the proper position, and the foot must be held so till the bandage is quite set. The plaster will require changing once every two or three weeks, and if, after some months, the proper position is retained after the plaster is removed, a shoe with metal straps, to prevent the recurrence of the deformity, should be substituted and kept in use for a long time. Sometimes it will happen that no amount of force that it is judicious to apply will bring the foot into proper position. Only in such an event is it proper to consider the propriety of cutting the tendons or ligaments that, by their shortness, are keeping the foot in its improper position.

In the case of a child who has acquired club-foot in consequence of paralytic disease, such as has been already mentioned, treatment is clearly not so simple. For here, besides the two things already mentioned as necessary to be done in all cases, there is a third, namely the restoration of the paralysed muscles. Whether this is possible or not must be decided for each particular case. If it can be done it is by the use of rubbing, massage, and electricity, begun early and patiently persisted in. If it cannot be done, then, besides bringing the foot back to its proper position and keeping it there, one must supply some sort of substitute for the weak or powerless muscles. There are some surgeons who make it their special business to treat these and other deformities. They are called orthopædic surgeons, and, if consulted early enough, such an expert will frequently be able to secure very remarkable results by the fitting of special apparatus to the particular case.

Sometimes the deformity is produced by injuries or burns, causing contractions, stiffness of muscles, and shortening of tendons. In such cases surgical treatment may be necessary, as a preliminary, in order to divide the constricting bands or shrunken tendons.

The reason why no time should be lost in attending to a case of club-foot is that, in a paralytic case, or one the result of injury, the healthy muscles, which, by being unopposed, draw the foot up, will in time become shortened and stiff and then the case is aggravated. A second reason is that the bones and joints get in time affected, altered, and render the cure much more difficult.

Flat-foot is a deformity resembling in appearance the second variety of club-foot. The foot loses its arch, and rests on its inner side. Pain and difficulty are experienced in walking, because the small bones of the foot have lost the proper relation to one another, owing to absence of the arch.

Treatment consists in placing a pad inside the boot, so as to support the inner side of the foot and restore the arch. To the inner side of the boot an elastic support may be supplied by india-rubber bands running up to and attached by a metal band round the knee. At the same time friction should be used to the weak muscles of the inside of the leg.

Knock-knee (*In-knee, Calf-knee, Genu-Vulgum*) is due, like flat-foot, to yielding of the ligaments and muscles round the joint. The knee is bent inwards at the joint. It is due to weakness, and is common in badly reared children, who are ill fed and live in a bad atmosphere in confined dwellings. Sometimes it occurs in children even before they have begun to walk; sometimes it arises in growing boys about twelve years of age, as the result of undue exercise, or fatigue in walking or standing, and living in a poisoned atmosphere.

The treatment should therefore first of all be directed to the nourishment of the child. To restore the natural position of the parts, when the child is lying the legs should be straightened, a pad put between the knees, and the ankles approached to one another by a bandage. For walking, an apparatus may be worn. A suitable one consists of a belt of steel round the hips, from each side of which a rod passes down the outside of the leg to be fixed in the outer side of the shoe. The rod should be of steel, bent outwards, and jointed at the knee. Opposite the knee-joint a broad elastic band should pass round the knee and be secured to the rod, so as to keep the knee from bending inwards. A bandage should also be similarly adapted in the middle of the thigh and in the middle of the leg. The apparatus must be used for many months before the cure is nearly complete. Care must be taken that the knee-joint is not allowed to become stiff through wearing the apparatus.

Bow-legs consist in a bending of the legs outwards, and are usually the result of a soft condition of the bone as in rickets. In such a case adopt the treatment for rickets (p. 71). Mechanical contrivances similar to that described above are in use for this affection also, though they are valuable mainly before the bones are quite firm. The condition can be greatly improved by operation.

Clubbed Hands are a rare defect; and the principles of their treatment are the same as those for club-foot.

Fingers may be drawn down towards the palm and there fixed by shortening of the tendons. This may have been due to burns of the palm of the hand and the contraction in healing, or it may have been caused by inflammation in the sheath of the tendon.

Rubbing and manipulation may do a great deal of good; often division of the tendon is required. To prevent contraction of the fingers during healing of a wound or burn, the finger should be kept straight by a splint.

Supernumerary Fingers and Toes are extra fingers and toes, often not properly developed, with which children are sometimes born. This deformity is frequently hereditary. The extra fingers or toes can easily be removed by a surgeon if necessary. Their possession has sometimes been known to cause such mental distress and vexation to sensitive girls as to lead to convulsions and frequent attacks of fits like epilepsy, a mere allusion to the deformity being sufficient to bring on a hysterical attack. On the removal of the annoyance by an operation, the tendency to fits has often completely disappeared.

SECTION VIII.

THE NERVOUS SYSTEM.

ITS STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

Nerve Cells and Fibres:
Their *microscopical structure.*
Their *association* in nerve-centres, nerves, and ganglia.
Their *functions.*
Nervous Action:—*Reflex action.*
The Cerebro-spinal System.
The Brain:
Its division into *Cerebrum, Corpora Striata, Optic Thalami, Corpora Quadrigemina,* and *Cerebellum;*
Its *peduncles, ventricles,* and *membranes;*
Its *microscopical structure,* blood-supply, size, and weight.
The Spinal Cord:—Its *structure.*
The Functions of the Central Nervous System.
The Functions of the Spinal Cord and Spinal Nerves.
Connections between the Brain and Spinal Cord.
Localization of Function in the Brain.
Phrenology.
Functions of the Various Parts of the Brain—
Cerebral Hemispheres, Corpora Striata, Optic Thalami, Corpora Quadrigemina, Pons Varolii, Cerebral Peduncles, Cerebellum, and Medulla.
The Cranial or Cerebral Nerves.
The Sympathetic System of Nerves.
The Distribution of Nerves.

THE ELEMENTS OF NERVOUS STRUCTURE.

No matter how complicated a nervous structure such as that of man may appear to be, it is found to consist essentially of two, and only two, elements, **nerve-cells** and **nerve-fibres.** The cells and fibres are combined and associated in various ways and are embedded in and supported by fine connective tissue so as to form a connected structure. The nervous tissue so formed is protected by membranes, and receives a rich supply of blood for its continued nourishment and growth, channels also being provided for the removal of its waste substances.

NERVE CELLS AND FIBRES.

Nerve-cells have a general resemblance under the microscope to other cells. They vary in size from $\frac{1}{5000}$ to $\frac{1}{400}$ of an inch. They consist of masses of granular-looking material—protoplasm—and contain a nucleus and nucleolus (see CELLS, p. 53), but have no cell wall. Processes or poles pass from the corpuscle or cell, branching outwards.

There are various kinds of nerve corpuscles, the main differences being in the shape of the cells, and in the number of processes given off from them. Some cells give off two, others many processes. One kind of cell is characteristic of one part of the nervous system. Thus, in Fig. 80, *a* and *e* show the appearances of cells found in the spinal marrow. They are large irregular masses of protoplasm, and give off many poles or processes, and are accordingly called **multipolar.** In the same figure *f* represents three cells from the large brain (cerebrum). They are triangular in shape, and give off a process from each angle, and another from the centre of the base of the cell. They are called **pyramidal nerve-cells** from their shape, and sometimes **tripolar,** that is, with three poles, though, as we see, they may have four poles. Cells from the lesser brain (cerebellum) are shown at *c* and *g.* They are rather oval in shape, and one or two branching processes come off from the small end of the oval. Those with one process are called **unipolar,** those with two **dipolar.** So characteristic are these forms of cells of special parts of the nervous system that under the microscope a small piece of spinal marrow could be identified simply by the presence in it of a multipolar cell, and a small piece

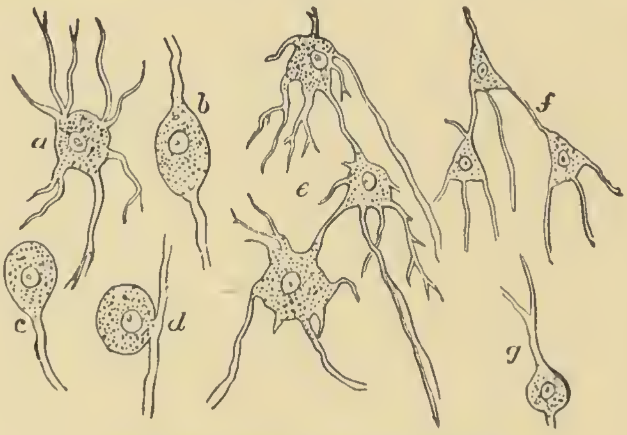


Fig. 80.—Various Forms of Nerve-cells.

of large brain simply by the presence of a pyramidal cell, and so on.

The processes of cells become important parts of nerve-fibres, as will be seen in considering nerve-fibres. Nerve-cells grow, manifest activity, and decay as do other cells (p. 54).

Nerve-fibres present the appearances shown in Fig. 81, *c* and *d*. They are of glassy transparency, and have a double outline as represented in the figure. They thus resemble tubes. The contents of the tube are of a clear jelly-like character. When stained by colouring agents nerve-fibres are found to consist of a rod passing down the centre, called the **axis-cylinder**, which is surrounded on all sides by a white substance, the **white substance of Schwann**, the whole being inclosed in a delicate sheath (**neurilemma**). At intervals gaps occur in the white substance, but the central core is continuous throughout the whole length of the nerve. In *a* and *b*, Fig. 81, the gaps in the white substance, which is as if stained black, are shown, and the axis-cylinder is seen crossing the gap. In some fibres (*e* of Fig. 81) no white substance exists, but only the central rod surrounded by the delicate sheath. A nerve-fibre resembles a wire prepared for conducting electricity, with its central rod of copper and its outer layer of gutta-percha, silk, or cotton, to coat the copper and protect it from contact with other conductors. The copper rod is the important part of an electrical conductor. Similarly the axis-cylinder is the important part of a nerve-fibre, and *it is found to be the continuation of a process of a nerve-cell.* Thus nerve-cells and nerve-fibres are related in that the process of one is the axis-cylinder and essential part of the other.

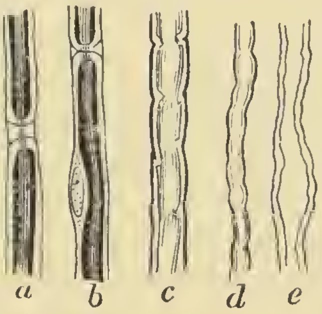


Fig. 81.—Nerve-fibres.

A Nerve-centre is a group, or several groups, of cells connected together by nerve-fibres, and associated together for a common function or purpose.

A Nerve is a cord formed of a bundle, or several bundles, of nerve-fibres, supplied with blood-vessels, and supported and surrounded by connective tissue.

Ganglia is the term applied to distinct and separate little masses of groups of associated nerve-cells with the fibres related to them.

FUNCTIONS OF NERVE CELLS AND FIBRES.

The functions of nerve cells and fibres are different. The cell is a highly active mass of living material; and it draws nourishment from the blood, supplied to it in abundance. That nourishment not only keeps the cell living, but is to be considered as raw material which the cell works up so as to derive from it force or energy. The cell is thus a little manufactory, deriving its raw material from the blood, and developing from it nervous energy. The nerve-fibre, again, is the conductor of the nervous activity; it affords the pathway along which the energy generated by the cell may be discharged. Of course the nerve-fibre, consisting, as it does, of living nervous substance, is also capable of generating energy, but its special function is to conduct influences to or from the cells.

Nervous Action.—It has been seen that nerve-fibres are in connection with nerve-cells, and that the fibres conduct the energy developed in the cell; and so the question arises, "Whither is the energy conducted, to what place does it proceed?" Well, in highly developed creatures like the higher animals and man, nerves proceed to nearly every tissue and organ of the body. They go to muscles and enter even into their very fibres; they are found in the coats of blood-vessels; they have recently been shown to be intimately connected with the cells of glands; they ramify through the skin; they are among the chief parts of the structure of the organs of sense. The activity sent to a muscle reveals itself in the contraction of the muscle, in movement; the activity sent to a gland produces increased action of the gland, increased flow of the gland secretion, the fluid prepared by the gland. Thus it is the organ at the end of the nerve—**the terminal organ**, as it is called,—and not the nerve-cell or the nerve-fibre, that determines the mode in which the nerve-impulse shall display itself. Nerves that proceed to muscles are called **excito-motor**, because the activity they conduct leads to motion; those that go to glands are called **excito-secretory**, because they excite to secretion; those that are found in the walls of blood-vessels are called **vaso-motor**, because they excite changes in the capacity of the vessels, make them wide or narrow, by causing the muscular tissue in their walls to contract or become relaxed; and there are others that are called **sensory**, for a reason that will be explained immediately. These names, as we have seen, are founded on a mistake, because it is not the fibre that determines motion, or secretion, or sensation, but the organ in which it ends, the terminal organ.

Another question arises, namely, When or why does nervous activity display itself? what causes a nerve-cell or a group of them to discharge its energy along a nerve, so that movement or some other effect is produced? The cause is called a **stimulus**, or an **excitation**. For example, a barrel of gunpowder is a store of energy, but the energy is quiet, latent, confined, and cannot reveal itself until it has been liberated. Apply a lighted match to the barrel: the match excites the powder, causing it at once to liberate and discharge its energy. The lighted match was the stimulus to the gunpowder. So nerve-cells and fibres require a stimulus before they will discharge or transmit their energy. Nerve structures may be stimulated *mechanically*, by pinching or pricking. They may be stimulated *chemically*; for example, something sour taken into the mouth causes at once a great flow of fluid—saliva—into the mouth, because the nerve supplying the salivary glands has been stimulated by the acid substance. Again, nervous structures may be stimulated *electrically*. Every one knows that if he takes into his hands the handles of a moderately strong electrical coil, his fingers close over the handles of the instrument, and though he desire it ever so much he cannot let go. That is because the electricity has stimulated the muscles, directly no doubt, but also through their nerves, to contract, and, so long as the stimulus continues, his muscles remain contracted, thus keeping his hands closed. *Heat* also will stimulate nerves.

Reflex Action.—Now nerve-cells may be stimulated *directly*, that is, the stimulus may be applied to the nerves themselves. Usually, however, the stimulus is not applied to the cells directly but is conveyed to them along a nerve. The nerve conducts the *impression*, which it has received, to the nerve-cells; and they, in turn, are stimulated, and discharge their energy along other nerves to muscles, glands, or other structures, as the case may be. There is thus a chain of events following the irritation of the nerve, and to the completed process a term of great importance in nervous physiology is applied, namely, **reflex action.**

Fig. 82 will render the meaning of this phrase more easily understood. In the figure, B is a nerve-cell. Leading to it is a nerve A coming from (1) some sensitive surface, say the skin. Connected with the nerve-cell is another nerve C, which passes to a muscle (2). Suppose something (a prick, sting, &c.) irritates the surface (1), immediately an impression is transmitted along the nerve A to the nerve-cell B. The cell receives the impression, is stimulated by it, and is thus caused to discharge its activity along the nerve C to the muscle (2), leading the muscle to contract. This is a simple reflex action, but there may be many much more complicated, in which there may be involved many cells and nerves, and many muscles or blood-vessels or glands, &c. The nerve A leading inwards to the cell is called a **sensory** nerve because it conveys the irritation that has been made on the surface. But sensory is not a good word, because no sensation or feeling need result. A better word is, therefore **afferent** (*ad*, to, and *fero*, I carry), meaning carrying *to* the centre. Similarly the nerve C may be called **efferent** (*e* or *ex*, from, and *fero*, I carry), carrying *from* the centre. Many of the movements and actions of our daily life are nothing more than complicated reflex actions. It is to be noted that such actions may occur without effort of will, and even without our being conscious of them. For example, tickle the sole of the foot of a sleeping man. He withdraws his foot, being at the time sound asleep and totally unconscious. This is a reflex act. The tickling has irritated some nerves of the skin; an impression has been transmitted along nerves upwards to nerve-cells in the spinal marrow. These nerve-cells, being stimulated, have discharged their energy along nerves proceeding to the muscles of the man's leg; the muscles have responded by contracting; and the leg has been moved. All this may have happened without sensation on the man's part, the nerve-centres involved in the action being in the spinal marrow. It is only when the impression reaches the brain by travelling up the spinal marrow that sensation or feeling can arise.

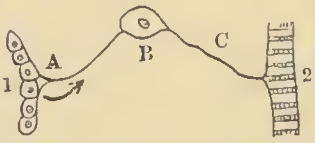


Fig. 82.—Reflex Action.

In warm-blooded animals, such as man, a nervous impression has been calculated to pass along a nerve at the rate of about 200 feet per second.

Nerve-energy is the energy or activity already alluded to as the chief object of the nerve-cell to create, and the nerve-fibre to conduct. Nerve-energy is one and the same thing in

PLATE XI

FUNCTIONS OF THE BRAIN

SHOWING THE POSITION OF VARIOUS REGIONS

This plate is meant to show the situation in the brain of the centres presiding over various movements of the body referred to on pages 147, 148, and 149.

The upper figure is from a cast of the head of an adult male. The scalp has been removed from one side of the head, and also nearly all the bone, arches of bone only being left to retain the brain in place and indicate the position of parts.

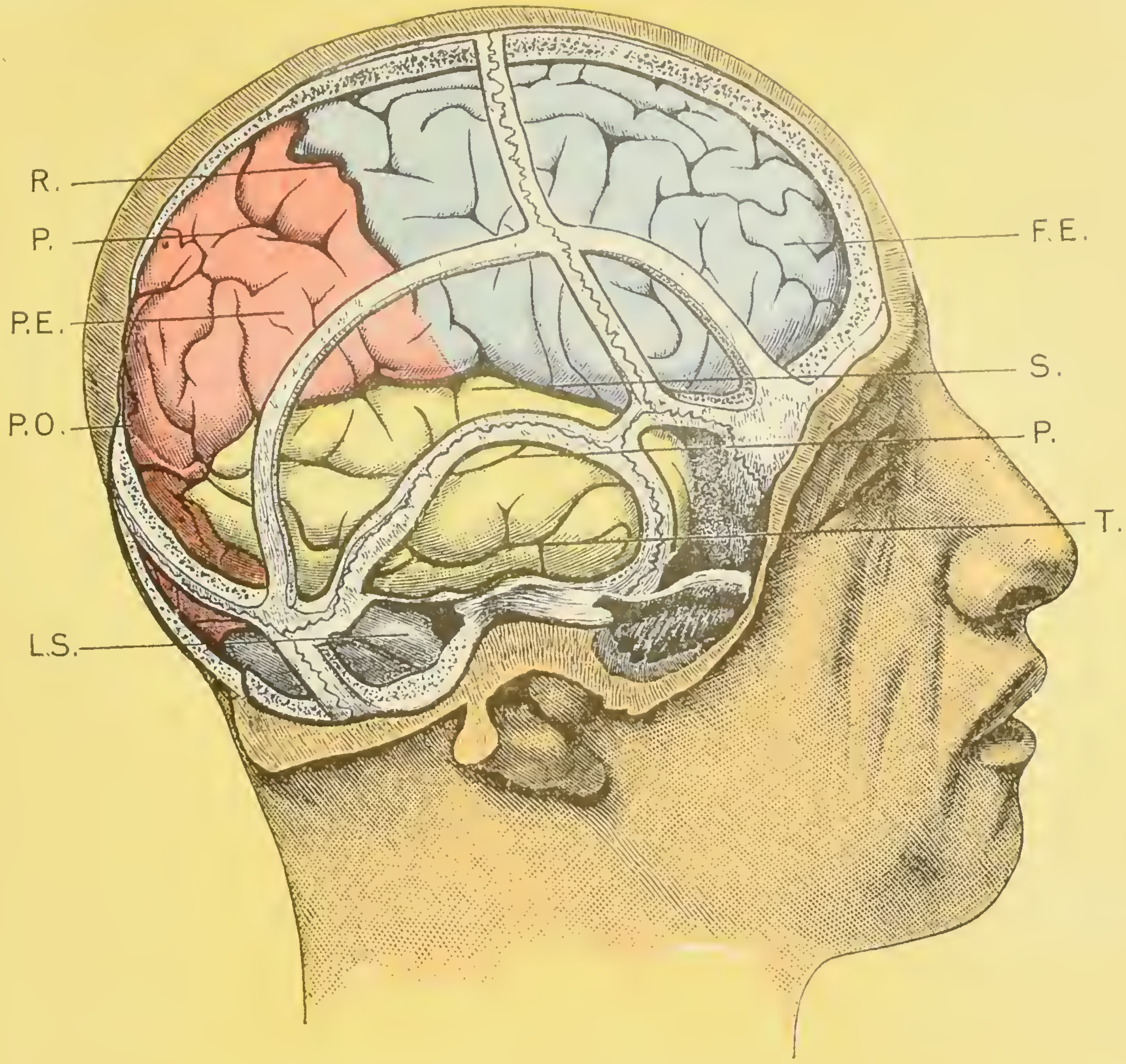
F.E. marks what would be the position of the prominent part of bone on the forehead, called the frontal eminence. P.E. indicates the position of the prominent part of the parietal bone on the side of the head, the parietal eminence. R. is the fissure of Rolando, P. the intraparietal fissure, P.O. the external parieto-occipital fissure, S. the fissure of Sylvius, P. parallel fissure, and T. middle temporal fissure. L.S. is the lateral sinus, a channel for the conveyance of blood from the brain to the veins of the neck. This figure, therefore, illustrates how from the outside of the head the position of various regions of the brain can be localized.

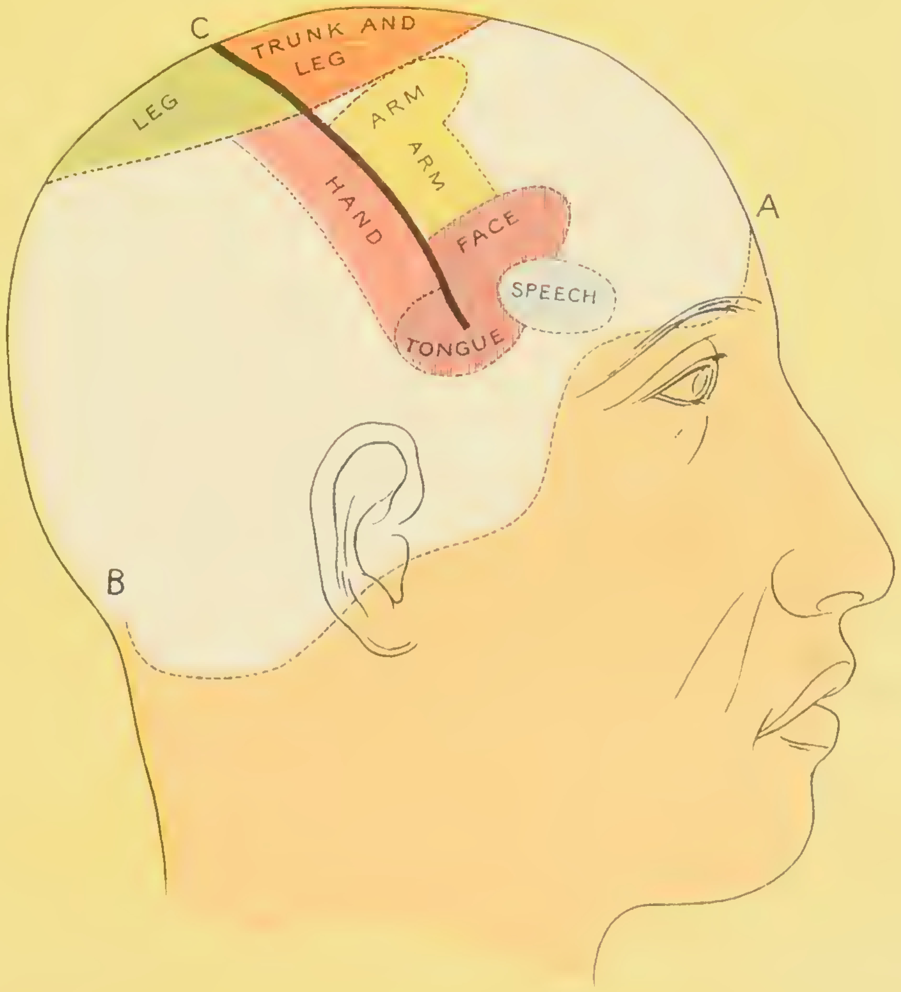
The convolutions immediately in front of and behind the fissure of Rolando contain the nerve centres for muscular movements, this region presides, that is to say, over the voluntary muscular mechanism of the body; the rest of the area, coloured blue, the frontal region, consists of convolutions concerned in intellectual operations; the rest of the area, coloured red, has to do with sensation, and specially with vision, while the area coloured yellow, temporo-sphenoidal region, has to do with hearing.

The lower figure illustrates the localization from the outside of the head of the situation, in the brain within, of various important centres. A B, curved line, indicates from the outside the relative depth of the various regions of brain within. C marks the top of the fissure of Rolando, on each side of which downwards the various centres are situated; and the regions in the convolutions of the brain devoted to movements of various parts of the body are shown.

These diagrams will render plain how the surgeon is guided, in an operation on the brain, in determining at what point to pierce the skull, in order to reach the particular part of the brain, which the symptoms suggest to be disturbed by pressure of a growth, or abscess, or some other removable cause.

FUNCTIONS OF THE BRAIN.





whatever part of the body produced. Ideas are as much the expressions of nerve-energy as the contraction of a muscle or the activity of a gland. But how nerve-energy is transformed into thought, or is the agent in the production of thought, or what is the kind of intermediate apparatus it stimulates to produce thought, all this we do not understand—perhaps never will. Nevertheless, a man whose nerve-energy is exhausted is as incapable of good intellectual activity as of good physical labour. Nerve-energy is produced by nerve-cells, and the nerve-cells manufacture it, so to speak, from the blood. In other words, their activity depends on the blood-supply they receive, and, naturally, not only on the quantity but also on the quality of the blood. Now the blood is nourished by the food taken. Other things being equal, by a proper quantity of food of the right sort, taken at proper intervals, the blood will be maintained in strength and purity, and will, therefore, be fit nourishment for the nerve-cells, as for other tissues of the body. It is necessary that this nourishment should be constantly renewed, because nerve-energy as well as the other forces of the body are being continually used up by the daily work of life. The nerve-cells will produce increased nerve-energy on the stimulus of a demand, but, to meet the demand, they must, in turn, be supplied with increased nourishment. Now suppose a man worried by business, neglecting to take his food at regular times, and consuming it hurriedly to return to business again, he is really using an increased quantity of nerve-energy, but allowing for the increased demand a *diminished* supply. The effects are naturally nervous exhaustion and nervous irritability, for nerves become more irritable as they become exhausted. This is all plain, and people can be got easily to recognize it and to admit it. But there are means of exhausting nerve-energy other than excess of work and diminution of nourishment—other causes not so willingly acknowledged. Two special causes ought to be observed, the first of which is the taking of stimulants to excess, or the constant use of opium and other similar drugs. The other form of excess is sexual excess, both of a legitimate and of an improper sort.

Without doubt, also, if nerve-cells were not being made use of, if there were no demand made on them for energy, they would grow feeble for want of action, degenerate, and finally die altogether. This has very important bearings on questions of training and education, which will be best considered in discussing the structure and functions of the brain.

THE CENTRAL, OR CEREBRO-SPINAL, NERVOUS SYSTEM.

It has been said that however complicated a nervous structure may appear to be it consists essentially of nerve-cells and nerve-fibres.

In the lower animals, the invertebrates, or those which have no backbone, cells are situated in groups in certain places in the body, and the fibres radiate from them to the various parts of the body, the groups being somewhat loosely connected with one another. But in vertebrates, animals having a backbone, the groups of cells are more closely connected together, and form central masses from which large trunks of nerves issue to be distributed to the various parts of the body. Thus one speaks of the **central nervous system.** In the higher animals and man there are two such central masses, which for better protection are surrounded by bone. One such mass, of a more or less globular form, is situated in the upper or forward end of the animal, inclosed within the skull, forming the **cerebral mass** or **brain** or **encephalon,** and the other, of an elongated columnar form, is situated within the central canal of the spinal column or backbone, forming the **spinal mass** or **column,** or spinal marrow, and these two are so connected that the spinal marrow becomes a prolongation of the brain mass. For this reason this central nervous system is also called the **cerebro-spinal nervous system.**

Before discussing the relations between these structures and the duties they perform, we shall describe their appearance and general arrangements. A general view of their position is shown in Fig. 83.

THE BRAIN.

(Plate XI.)

The brain proper consists of the **cerebrum,** or larger brain, which occupies the whole of the upper and front parts of the cavity of the skull, the **cerebellum,** or lesser brain, lying beneath the hinder part of the cerebrum, and the

medulla oblongata, or oblong marrow, which may be regarded as a continuation of the spinal cord within the cavity of the skull, and as forming the connection between the brain and cord. Included also in the brain are certain masses of nervous matter to be afterwards described, lying towards the floor of the cavity of the skull, covered over and concealed by the larger brain, and called **basal ganglia**.

The cerebrum and cerebellum are almost completely divided into two lateral halves by a deep longitudinal fissure, and the surface of the former is divided by a considerable number of irregular furrows, nearly an inch deep, into **convolutions**. As the gray matter of the brain spread out on its surface is the portion having the highest functions, its quantity is largely increased by being thus thrown into convolutions.

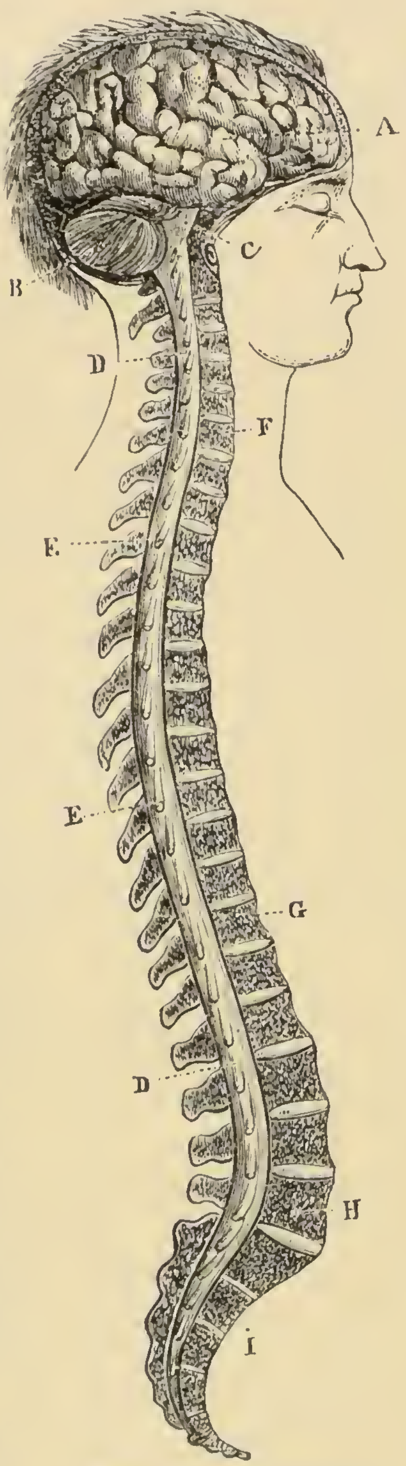


Fig. 83.—Position of Brain and Spinal Cord.

A, Cerebrum, or brain proper. B, Cerebellum. C, Pons Varolii, and below it the medulla oblongata. D D, Spinal marrow, showing the origin of the spinal nerves. E E, Spinous processes of the vertebræ. F, 7th cervical vertebra. G, 12th dorsal vertebra. H, 5th lumbar vertebra. I, Sacrum.

The **Cerebrum** is oval in form, arched above and somewhat flattened on its lower surface, which rests on the floor of the skull. Usually its anterior or frontal portion is somewhat narrower than the hinder portion, and its greatest breadth is between the ears. The great fissure, running from before backwards, divides it into **two hemispheres**, but these are connected by a large band of nervous matter, seen in Fig. 86, B, called the **corpus callosum**. Each hemisphere is divided by anatomists into anterior, middle, and posterior lobes, corresponding generally to the same regions of the skull. The general appearance of the surface of the cerebrum is seen in Fig. 84.

The under surface of the brain (Fig. 85), which rests on the floor of the skull, shows the origins of the important nerves, called the **cranial nerves**, the **cerebellum**, the **optic commissure** (2-2) or structure connecting the optic nerves, the **pons Varolii** (PV) or bridge of nervous matter connecting together the two hemispheres of the cerebellum, and lastly numerous **convolutions**.

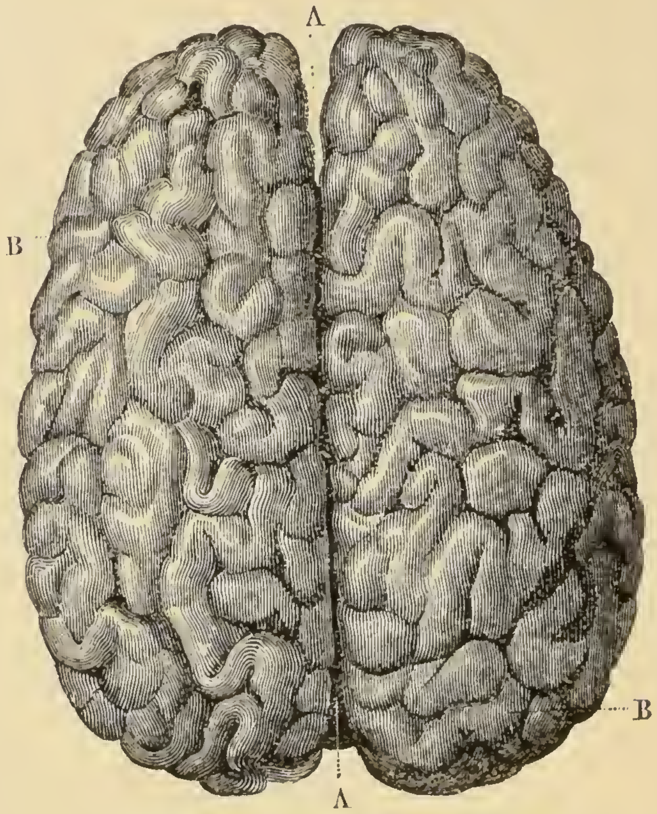


Fig. 84.—View of Upper Surface of the Brain.

A A, Great longitudinal fissure. B B, Cerebral hemispheres.

Basal Ganglia.—If we divide the brain into two portions by cutting lengthwise through the great longitudinal fissure, and dissecting a short way towards either side, we find that each hemisphere covers over several large masses of nervous matter, which have been called the **ganglia at the base of the brain.** These are, from before backwards:

(1) Two bodies streaked on the surface, and hence called **corpora striata**, or striated bodies;

(2) Two bodies behind and a little to the outer side of the corpora striata, supposed by the older anatomists to be connected with vision, and hence called the **optic thalami**, or optic masses; and

(3) Four bodies, two on each side, called **corpora quadrigemina**, or twin-like bodies.

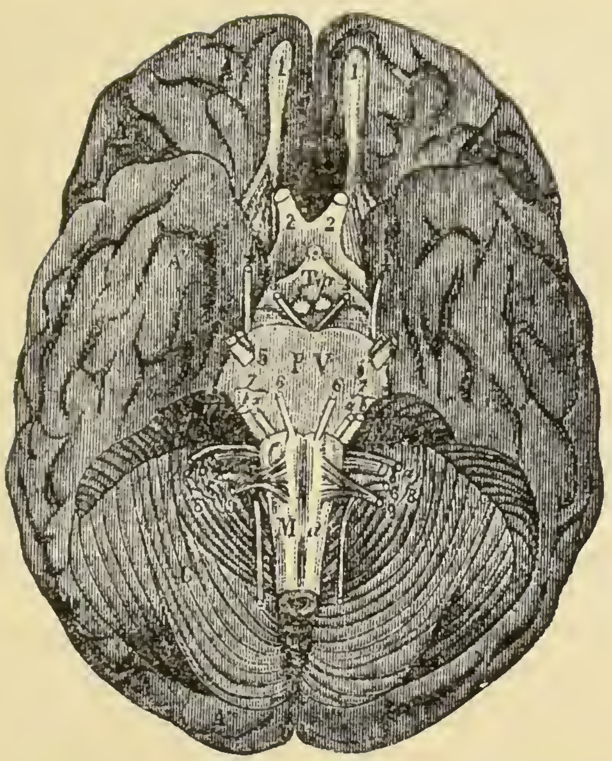


Fig. 85.—View of the Lower Surface of the Brain, showing the beginnings of the Cranial Nerves.

A, Anterior lobe. A′, Fissure of Sylvius. A″, Middle lobe. A‴, Posterior lobe. C, Cerebellum or lesser brain. M*a*, Medulla oblongata. PV, Pons Varolii. T*p*, The pituitary gland. 1-1, First pair of nerves, or *olfactory* nerves. 2-2, Second pair, or *optic* nerves. 3-3, Third pair, or *common motor nerves* to *muscles of eyeball*. 4-4, Fourth pair, or *pathetic nerves* for one muscle of eyeball. 5-5, Fifth pair, *trifacial* or *trigeminal*, giving sensibility to face, tongue, and teeth, and motion to muscles of mastication. 6-6, Sixth pair, or *abducent* nerves, to external rectus muscle of eyeball. 7-7, Seventh pair, consisting of two portions—*a*, *facial*, giving power of motion to muscles of face, and *b*, *auditory*, or nerve of hearing. 8-8, Eighth pair, consisting of three portions—*a*, *glossopharyngeal*, supplying sensibility to tongue and back of throat, also partially motor; *b*, *pneumogastric*, supplying throat, heart, lungs, and stomach; and *c*, *spinal accessory*, giving motor power to certain muscles of neck. 9-9, Ninth pair, or *hypoglossal*, supplying power of motion to tongue and to several muscles in neck.

All these parts of the brain are connected with each other by numerous nerve-fibres. The fibres from the spinal cord pass upwards in the medulla oblongata, those from the hinder part going chiefly to the cerebellum, whilst those from the front pass chiefly to the cerebrum. In the cerebrum, cerebellum, and ganglia we also find fibres running from one part to another, as from before backwards and across, so as to unite all the parts of the brain and form one complete organ.

A side view of the brain is seen in Fig. 86, which should be studied with the aid of the description.

The **cerebellum**, or lesser brain, lies in the back part of the skull cavity, and is covered over in man by the hinder lobe of the cerebrum. It is, as it were, slung on the back of the cerebro-spinal axis, and consists of two hemispheres with an intermediate portion, or middle lobe, sometimes called the **vermiform process**. The whole surface of the cerebellum is divided into convolutions by irregularly-shaped furrows passing crosswise.

The Peduncles or Crura of the brain are thick bands of fibres which connect cerebrum, cerebellum, and spinal cord. Thus, connected with the cerebellum, there are three pairs of peduncles, two joining it to the spinal cord below, two to the cerebrum above, and two passing crosswise and forming the **pons Varolii.**

The **ventricles** of the brain are cavities varying in size which exist in different parts. Thus in each half of the cerebrum there is such a cavity, the **lateral ventricle**. Between the hemispheres of the brain in front is the **fifth ventricle**, and further back the **third ventricle**. A considerable space exists between the back of the medulla oblongata and the under surface of the cerebellum which rests upon it. The space is called the **fourth ventricle** (see Fig. 86), and in its floor are many very important nerve-centres. A small amount of fluid exists in health in these cavities; but in some diseases, such as "water in the head", the quantity of fluid is enormously increased.

The minute structure of the brain consists of *white* matter internally, and *gray* matter externally. The white matter is more firm and consistent than the gray matter; indeed the latter is so soft as to be readily washed away from the brain soon after death by a jet of water. The gray matter forms a layer or web over the surface of the cerebrum and cerebellum, and it also exists in

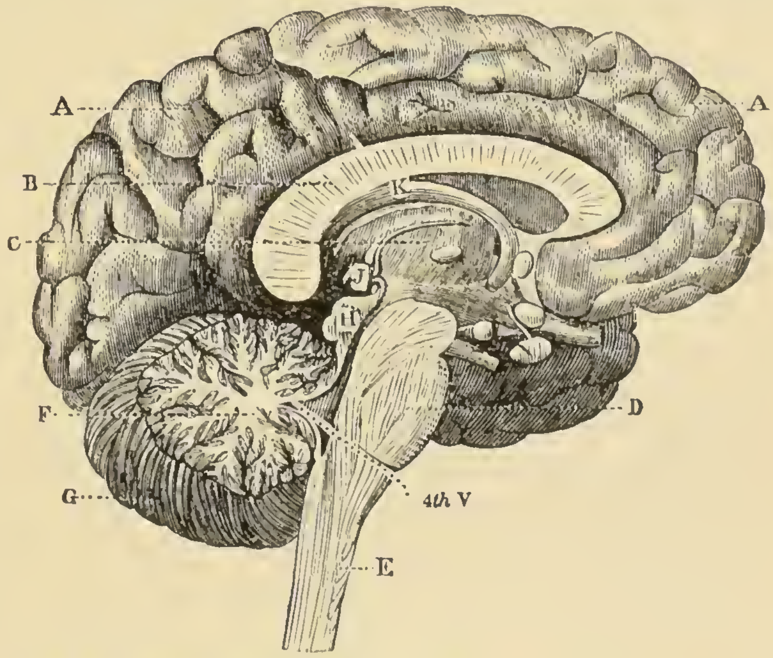


Fig. 86.—View of a Section of the Brain in the Middle Line. The inner aspect of the left side is seen.

A, Plane of the great fissure. B, Corpus callosum. C, Optic thalamus. D, Pons Varolii, under which is seen the medulla oblongata, or cranial portion of the spinal cord. E, Spinal cord. F, Section of cerebellum, showing its peculiar leaf-like appearance which has given it the name of "tree of life." G, Left half of the cerebellum, showing convolutions. *4th* V, Fourth ventricle.

masses at various points in the deeper parts, as for example in the corpus striatum, optic thalamus, corpora quadrigemina, pons, medulla, and cerebellum. The white matter constitutes the greater portion of the internal parts of the brain. As brain substance is too soft and too opaque in the natural condition for microscopical examination with high powers, physiologists have devised methods by which portions may be hardened so that thin sections may be cut. These sections are immersed in dilute solutions of such dyes as carmine or logwood, with the effect of staining certain parts of the structure, and thus rendering them visible. When such sections are properly prepared and mounted for microscopical examination it is found that the white matter in the deeper parts of the brain consists of nerve-fibres bound together by fine connective tissue. The gray matter consists of a very fine variety of connective tissue to which the name **neuroglia** has been given, and in this lie embedded the nerve-cells, already described (p. 128.)

The **meninges** are the membranes which invest and protect the brain and cord. These are: (1) a strong outer fibrous membrane named the **dura mater**, which closely lines the interior of the skull and forms a loose sheath in the spinal canal; (2) an inner thin membrane called the **pia mater**, which is closely adapted to the surface of the brain and spinal cord, and, being crowded with blood-vessels, carries to them their blood-supply; and (3) an intermediate membrane, the **arachnoid**, which lies over the pia mater and under the dura mater. The dura mater may be regarded as the protective covering of the brain, and the pia mater as a special membrane on which blood-vessels divide and subdivide, so as to be of very small size before they penetrate the brain; whilst the arachnoid is really a double membrane, one layer being adapted to the dura mater and the other to the pia mater, the space between these occasionally containing a small quantity of fluid. These membranes are sometimes the seat of inflammation.

The brain is very richly supplied with blood. The main arteries enter the base of the brain, dividing and subdividing until they become of very small size; whilst the chief veins tend towards the surface of the hemispheres, where they enter into great cavities or **sinuses**, by which the blood is carried off to the great veins of the neck. The special feature of the arrangements for the blood-supply of the brain is that only very small vessels ramify in the brain substance. The gray matter contains a much denser net-work of fine vessels than the white matter.

The **average weight** of the human brain is about 49 oz. for the male and 44 oz. for the female, the average male brain being thus about 5 oz. heavier than that of the female. In both sexes the weight of the brain increases rapidly up to the seventh year, then more slowly to between sixteen and twenty, and again more slowly to between thirty-one and forty, at which time it reaches its greatest size and weight. As age advances it diminishes in weight at the rate of about 1 oz. for each period of ten years.

Other things being equal, the size and weight of the brain bear a general relation to the mental power of the individual. The brains of many eminent men have been found to be 8 to 14 oz. above the average weight, but these are notable exceptions. The brains of idiots are always small; indeed, any weight under 30 oz. seems to be invariably associated with idiocy. The human brain is absolutely heavier than that of any other animal except the whale and the elephant. The brain of a whale, 75 feet long, weighed upwards of 5 lbs., whilst that of an elephant is from 8 to 10 lbs. The average proportion of the weight of the brain to the total weight of the body is greater in man than in most other animals, being about 1 to 36·5; but in some small birds, the smaller monkeys, and in some other animals the weight of the brain to that of the body is even greater than what it is in man.

THE SPINAL CORD.

The spinal cord is in direct continuation with the brain by means of the medulla oblongata, and passes down the back, lodged in the canal formed by the rings of the vertebrae. It is from 15 to 18 inches long, and terminates at the level of the first lumbar vertebra, tapering off to a fine thread. It is about the thickness of the little finger, but is thicker in the region of the neck, where the nerves for the upper limbs pass off, and also at the lower or lumbar end, where the nerves for the lower limbs emerge. Like the brain it is closely invested by a very delicate membrane, the **pia mater**, by which blood-vessels are conveyed to the substance of the cord, having also an outer tough, fibrous coating—the **dura mater**. Between these two are the delicate serous layers of the **arachnoid** membrane inclosing a space between the dura and pia mater. This space contains a certain amount of fluid—the **cerebro-spinal fluid**, similar to the fluid in the ventricles of the brain. Finally, between the cord inclosed by its three membranes and the bony walls of the spinal canal there is a considerable amount of fatty tissue, acting as a packing material, embedded in which are some large blood-vessels. Thus the cord is supported in the canal by its membranes; and by means of them and of the fluid and packing of fatty tissue it is protected from shocks and jars. Nerves, the **spinal** nerves, pass out from the cord at regular intervals along each side. There are thirty-one of these on each side; and they receive sheaths from the delicate membranes of the cord, but pierce the dura mater. They issue from the bony canal by apertures, the intervertebral foramina, left at the sides between the opposing surfaces of the vertebræ, and, having escaped from the backbone, they pass backwards and forwards ramifying in the soft parts of the body. The first pair of nerves comes off between the skull and atlas, the next pair between atlas and axis, and so on down the canal. Thus eight pairs come off in the region of the neck—the **cervical** nerves, twelve pairs are **dorsal**, five are **lumbar**, and five **sacral**, while the last pair comes off behind the **coccyx**. The upper pairs come off at intervals and pass directly outwards through the openings in the canal for them. The lower pairs, however, to which belong the large nerves for the lower limbs, come off very near one another at the lower end of the cord and then pass down the canal in a bundle called **cauda equina**, from their resemblance to the tail of a horse, one pair passing outwards, one after the other, as they reach their respective openings. (Refer to Fig. 87.)

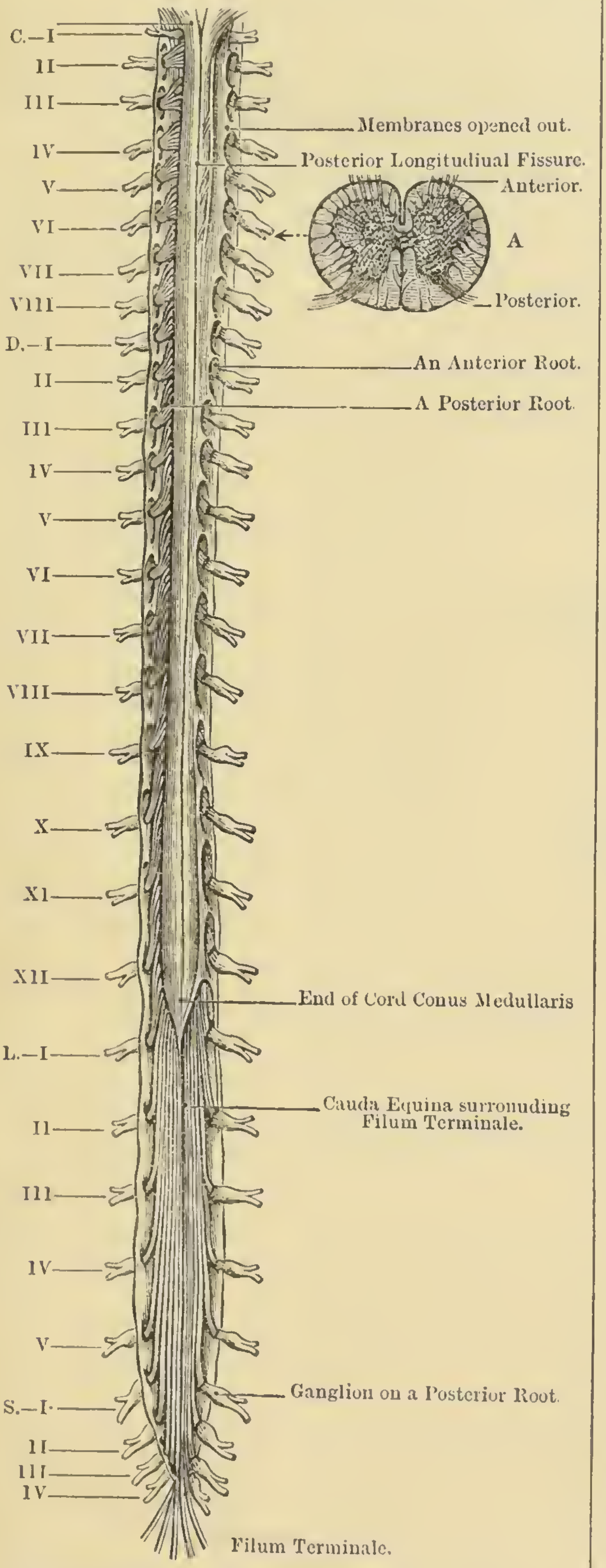


Fig. 87.—Representation of Human Spinal Cord—reduced.

C. I to VIII, Cervical spinal nerves. D. I to XII, Dorsal spinal nerves. L. 1 to V, Lumbar spinal nerves. S. I to IV, Sacral spinal nerves. A, In upper right-hand corner cross section of cord at level of 6th cervical nerve-roots.

The **structure** of the spinal cord resembles the brain, consisting of gray and white matter, but the arrangement is different. In the brain the white matter is within and the gray matter is spread on the surface of the convolutions. In the spinal cord the gray matter, which is characterized by large cells with many processes represented in Fig. 80 (*a* and *e*), is gathered *in the centre* into two half-moon-shaped masses, the backs of the masses being connected at the central part of the cord. The white matter, consisting mainly of fibres, is outside of and surrounds these gray crescents. In the centre of the cord, in the midst of the bridge of gray substance that unites the gray crescents, is a microscopically small canal, the **central canal** of the cord, which is continuous with the fourth ventricle of the medulla oblongata. The cord itself is almost divided into two lateral halves by a fissure or cleft which passes backwards from the middle line in front to within a short distance from the central canal. A division is also made behind between the right and left half of the cord by a partition of the pia mater that dips inwards from the middle line behind, also to a very short distance from the central canal. Thus there is formed a division, as it were, between the right and left side, each side having its own gray crescent, the horns of which point one forwards and the other backwards. The horn pointing forward is called the **anterior horn or cornu**, the other is the **posterior horn** or cornu. Now from these horns there pass off strands of nervous substance which form the roots of the spinal nerves. Thus, from the anterior horn of one side there passes off a strand which issues from the cord towards the front, and is the anterior root of a spinal nerve; from the posterior horn of the same side a strand passes off behind to form the posterior root of a spinal nerve. These two strands, having issued from the cord, curve round, meet and join one another at the side, and by their union a spinal nerve of one side is formed, which then passes out of the canal by its intervertebral opening. Similarly from the other side a spinal nerve is formed by the union of an anterior and posterior root. On the posterior root, before it joins the anterior, is a ganglion, *g* of Fig. 88.

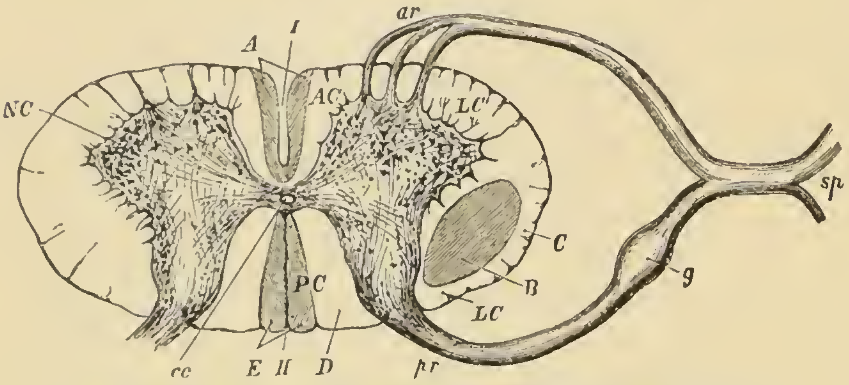


Fig. 88.—Cross Section of the Spinal Cord. Partly diagrammatic. Magnified. For references see text, and also p. 146, where certain references not requiring notice here are explained.

Fig. 88 represents the spinal cord cut across, as it would appear on looking down on the cut surface of the section. I is the fissure in front, II is the division between right and left behind, caused by the dipping in of the pia mater. The shaded portion in the centre represents the gray crescents with the connecting bridge, in the middle of which is the central canal, *cc*; *ar* is the anterior root, *pr* the posterior root. The two roots unite to form the spinal nerve *sp*, and the nerve afterwards divides into two divisions, one going to the back of the body, and the other going to the front of the body.

The roots of the spinal nerves map off the white matter of the cord into columns. Between the anterior root of each side and the anterior fissure is the **anterior column**, AC, between the two roots at each side is the **lateral column**, LC, and between the posterior root and the posterior fissure is the **posterior column**, PC. In the white matter there are no groups of nerve-cells, but in the gray crescents are numerous groups of nerve-cells, NC, specially in the anterior cornua. These are roughly indicated in the diagram.

THE FUNCTIONS OF THE CENTRAL NERVOUS SYSTEM.

To disentangle the fully-developed human nervous system, or that of any of the higher animals, in order to determine the relations and duties of the various cells and fibres of which, as we have said, it is built up, would be an impossible task. The structure is so delicate, the weaving and interweaving of fibres are so complex, the orderly disorder of cells so great, that the destruction of the tissue is the main result of any attempt to unravel it. Nevertheless various methods of inquiry and experiment yield a fairly consistent general view of the relations and functions of the different strands of fibres and groups of cells, though, to render one's knowledge full and exact, innumerable details remain yet to be discovered.

The study of the development of the nervous system, from the lowest organism possessing any nerve structure at all up to man, and the gradual increase in its complexity from below upwards, attended, as such increase of complexity always is, by greater elaboration of function, throws much light upon the problem. The study of the development of the nervous system in one kind of animal has of recent years yielded much valuable information, since it is found that certain strands of fibres in the spinal cord reach their full development sooner than others. The examination of the spinal cord of an animal in a stage of its development will show certain fibres fully formed, others only in process of formation, and the course of the fully-formed fibres can therefore be traced through the cord and distinguished from those of the less fully-formed fibres. Further, the spinal cord can be removed from the body of a newly killed animal, can be hardened by various reagents so as to stand being cut into slices—sections, as they are called—of extreme tenuity, and stained by pigments of various hue. All the fibres are not alike when viewed under the microscope, but vary in size and in other respects, so that by cutting a continuous series of sections, staining them, and mounting them on glass slides in proper order, groups of fibres can be traced by their microscopic characters from one section to another onwards in the cord.

Experiment yields much information. Thus, if the destruction of a limited area of the cord is followed by loss of power in certain groups of muscles, the conclusion is obvious that the fibres in that part of the cord conduct impulses leading to the movement of these muscles; or if stimulation, say by an electric current, of a definite limited region on the surface of the brain in a living animal always leads to the action of the same muscle or group of muscles, the conclusion is obvious that that area of brain is related to the particular movement. This conclusion would be strongly confirmed if destruction of that particular area were always followed by the loss of that particular movement and by no other obvious effect.

Nature, unfortunately, "so careless of the single life," is prone to experiment by the agency of disease with far greater frequency and freedom than the experimental physiologist or pathologist, and the examination, after death, of the brain, cord, and nerves of a person who has died of some nervous disorder, and the relation of the alterations found in the diseased structure with the symptoms observed during life, have been prolific of information.

By collecting and comparing all the facts derived from these various methods of observation and inquiry, our present knowledge of the connections and functions of the nervous system has been built up.

What the nature of that knowledge is an attempt will be made to set forth briefly and with as little elaboration and detail as possible, anything beyond a very broad and general view being impossible in a treatise such as this.

The earliest indication of a nervous structure is found in that class of animals to which, among others, the polyps and medusæ belong (Cœlenterata). The hydroid polyp is tubular in shape, and consists of an outer and an inner layer of cells, between which is a middle layer of modified cells. If any part of the outside of the animal be touched it responds by moving. This response to an external stimulus is not in itself proof of the existence of a nervous structure, for apparently undifferentiated protoplasm will so respond. But microscopical investigation has shown that certain of the cells of the outer wall are peculiarly modified on their outer or exposed ends, and that from their inner deep ends processes run in to the middle layer. It is believed that these peculiar cells are fitted to receive an impression from contact with an external body, which impression they transmit by the deep processes to the middle layer, the result of which is contraction of the middle layer and the movement of the body.

Here, then, is the beginning of a nervous system, one cell placed on the surface so modified as to be fitted to receive and transmit an external impression to another cell, deeply placed, modified so as to contract on the receipt of the stimulus, a process of the surface-cell being the channel of communication.

In the medusæ the anatomical structure is more elaborate. Here there are special cells on the surface, fitted to receive external impressions, and cells placed deeply, modified into fibres, fitted to contract when stimulated, as in the polyp, but the connection between the two is less direct. Delicate filaments connect the outer cell with the deeper fibre. But in the course of the filaments is a mass of nucleated protoplasm, a nerve-cell. So that the external impression is made on a surface-cell, transmitted from it to a nerve-cell by a fine filament, and then by means of another filament the impulse is passed on to the muscle-fibre, resulting in a contraction. Here the nerve-cell is the intermediary between the outer perceiving cell and the deep contracting fibre, and there can be no doubt that the intermediary nerve-cell plays a more important part than merely transmitting the impulse inwards. The filaments connecting the nerve-cell, on the one side with the surface, on the other side with the deep parts, we may now call nerve-filaments. Moreover, the nerve-filaments are so numerous as to form a marked ring of fibres running in the margin of the bell, and the cells lie among them, and there cannot be a doubt that the arrangement is not simply that of one cell on the surface being connected through the medium of nerve-filaments and cell with one muscular fibre deeply placed, but a more complex one by which intercommunicating nerve-filaments connect nerve-cells with one another. As a result of this intercommunication it is possible to have not only definite limited movements of simple muscle-fibres, but complex, co-ordinated movements, in which numerous fibres take their appropriate part. For, corresponding to the increased complexity of the anatomical structure, there is increased complexity of function, the medusa responding to an external stimulus, not merely by a single simple movement, but by complex movements, for example, of locomotion, or by discharge of stinging cells for defence, or by modification of the three, or by some movement indicating not merely the fact that a stimulus has been perceived, but even that the position of the stimulated part of the surface has been appreciated.

Now, when in the light of such facts an animal higher in the scale is examined, the character of the nervous system is more easily understood. The nerve-cells are found collected into more well-defined groups and the nerve-filaments into more well-defined strands. The groups of cells with the fibres connecting them together are called **ganglia**. The strands of nerve-fibres obviously connect the ganglia with well-defined areas of the body, certain nerve-fibres connecting the ganglion with the surface of the body and others with the deeper parts. The essence of the functions they perform is the same. Some stimulus, applied to the surface, will cause an impression to be conveyed to some cells of the ganglion, and then from these cells an impulse will pass by other fibres to deeper parts, leading to movement or some other action. Moreover, one ganglion is visibly connected with another, so that the impression received by the cells of one ganglion, which takes note of stimuli affecting one part of the body and regulates the actions of that part, may be communicated to the ganglion of another part of the body, leading to co-ordinated action of both parts. In the crab there are two main ganglia (Fig. 89), connected together, with numerous nerve-bundles radiating from them.

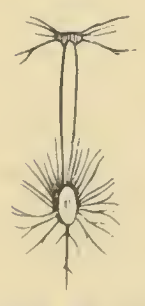


Fig. 89.—Nervous System of a Crab.

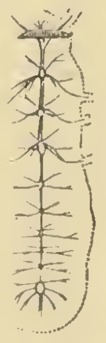


Fig. 90.—Nervous System of an Ant.

In animals still higher in the scale of organization the increase in the development of parts and in the complexity of functions necessitates more numerous ganglia and more numerous fibres, connecting them with the region of the body over which each ganglion presides, and with one another. Thus in the ant (Fig. 90) there is a regular chain of ganglia and intercommunicating fibres.

Movement, in response to an external stimulus, has been taken as the illustration of nervous action, because it is the most obvious one. So increased variety of possible movements, the appearance of rhythmical movements, and the adjustment of limited movements for particular purposes, have been referred to as illustrations of increased complexity of function necessitating increased development of nerve fibres and cells. But lest the exclusive use of this illustration should mislead the reader, it is necessary to say, what is of course obvious, that the gradual increase in the development of parts and complexity of functions, observed as one ascends in the scale of animal life, may be illustrated in a multitude of other ways, for instance in the appearance and development of digestive organs, of a heart and blood-circulating apparatus, of secreting glands, of organs for the removal of waste substances from the body, such as lungs and kidneys. The functions which all these parts perform are maintained and regulated by nervous action. Just as the action of a muscular fibre is performed in response to a stimulus from a nerve-cell, and just as that nerve-cell discharges its stimulus down a nerve to the muscle in response to some impression received from without, so all the organs referred to are caused to perform their functions by impressions from nerve-cells conveyed to them along nerve-fibres. So also the nerve-cells do not act automatically or spontaneously in controlling the action of the various organs, but are roused to action by impressions reaching them from without. The increase in nerve-ganglia, therefore, and in the nerve-fibres connecting them with different parts of the body and with one another, which is observed as one passes from lower to higher animals, is necessitated by development in a great variety of ways.

A phrase has been used suggesting that a ganglion presides over a part of the body, receiving impressions from it by one set of fibres and controlling the changes in it by impulses discharged along other fibres. It has also been mentioned that one ganglion is connected with others, so that the changes going on in one part may be related to those going on in another, that the harmonious working of all the parts may be maintained. This is specially well seen in certain animals, such as worms, where the body of the animal obviously consists of a series of segments, arranged longitudinally, each segment in its main features resembling the others. Each segment has its own ganglion or ganglia and related nerves. Still further, in animals of a certain degree of organization there is an obvious symmetry between one side of the body and the other, so that the body can be divided into two lateral halves markedly resembling one another; and this symmetry is reproduced in the nervous system. Instead of one ganglion presiding over one segment of the body with its related nerves, there is a pair of ganglia side by side, each with its related nerves, and each presiding over its lateral half of the segment, the two being closely connected by fibres passing between. Fig. 91 illustrates such paired ganglia, in which the two ganglia are close together, the fibres connecting them not being, therefore, obvious, but in other animals they are widely separated, and the **commissural fibres**, as the connecting strands are called, are quite distinct.

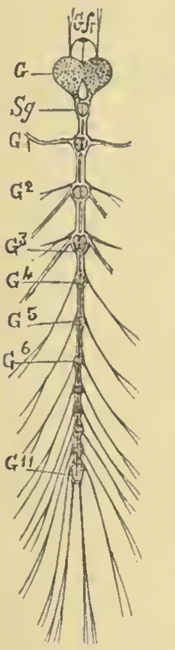


Fig. 91. — Nervous System of the Larva of Coccinella.

G, Ganglion in front of gullet. *Gfr*, Frontal ganglion. *Sg*, Ganglion below gullet. *G*1 to *G*11, Ganglia of chest and abdomen.

Here we must repeat that however ganglia are multiplied by the requirements of increasing complexity of structure, and however numerous and large become the nerve strands connecting them together, the type and essence of the whole structure is that already described. The type is a nerve-cell with a nerve-fibre carrying an impression inwards, which impression provokes some change in the cell, as a result of which an impulse is discharged outwards by another nerve-fibre, resulting in some change in muscular fibre, or blood-vessel, or gland, or other structure. The fibre carrying the impression inwards is called an **afferent or sensory fibre**, and the fibre conveying the impression outwards, **efferent or motor fibre**, and the process is known as a **reflex action**. Refer to page 132, where this is more fully explained. We may now add that while an afferent fibre carries impulses only inwards to the cell, and the efferent only outwards to the muscle, vessel, gland, &c., the two fibres may, and indeed very commonly are, bound up in the same strand or nerve-trunk. The nerve-trunk in such a case contains both motor and sensory fibres, conveys impulses, that is to say, both outwards and inwards. This is called a **mixed nerve**.

Now let us see what stage we have arrived at in our effort to understand the building up of a nervous system. The simplest conceivable nerve mechanism is a nerve-cell with an afferent and efferent fibre. Nerve-cells are grouped into ganglia, nerve-fibres into strands. As complexity of structure increases, ganglia, and the nerves connecting them and the various organs and parts of the body, multiply, but they are more or less symmetrically arranged, till a double chain of ganglia with connecting strands is reached. As complexity goes on increasing, the ganglia come to be more closely placed, till they and their connecting strands become fused, so that at last a continuous cord is developed, nerves radiating from it.

Fig. 92 illustrates the nervous systems of a frog and a bird. Let the brain be neglected in each case. In the frog the bilateral arrangement is shown by the groove partially dividing the spinal cord into two lateral halves, while the segmented arrangement is just indicated by the regularity with which the nerves come off from each side. Here, that is to say, the chain of paired ganglia with their commissural fibres have become fused into a continuous cord, the construction of which it would be impossible to understand but for the previous study of more elementary forms.

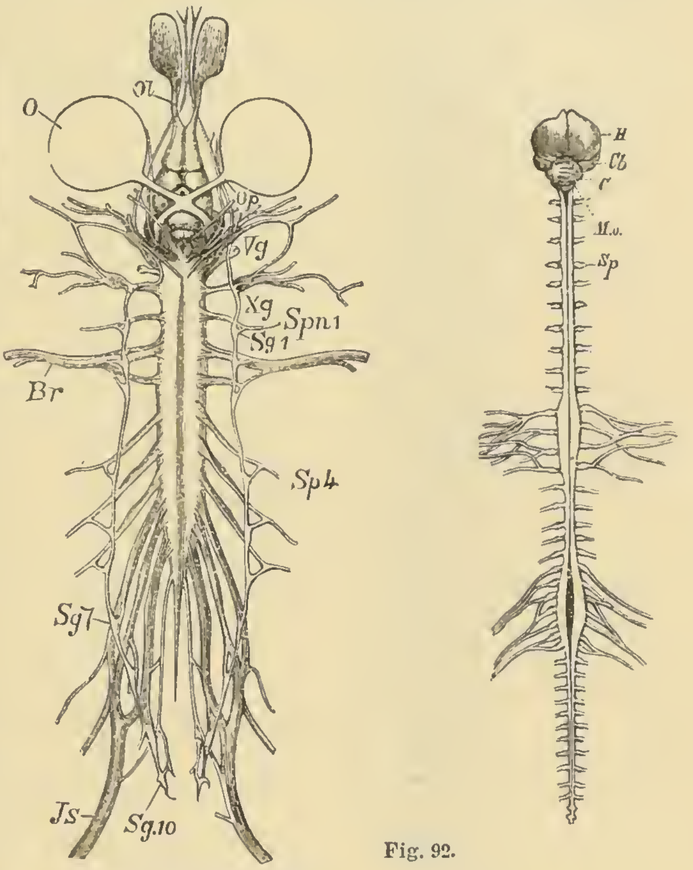


Fig. 92.

Nervous System of the Frog.

Ol, Olfactory nerves. *O*, Eye. *Op*, Optic Nerve. *Vg*, Gasserian ganglion. *Xg*, Ganglion of vagus nerve. *Spn*1, First spinal nerve. *Br*, Nerve to anterior extremity. *Sg*1 to 10, Ten ganglia of sympathetic system. *Js*, Ischial nerve.

Nervous System of the Pigeon.

H, Great brain. *Cb*, Optic lobes. *C*, Small brain. *M o.*, Medulla. *Sp*, Spinal nerves.

The similarity between these and the spinal cord of man is too obvious to need comment (Fig. 93). The bilateral symmetry of the human body is quite apparent, and if the development of the human body be studied, its segmented arrangement becomes quite clear. Thus the study of comparative anatomy and of development would lead one to conclude that the spinal cord of man and the higher animals consists essentially of paired ganglia arranged longitudinally, the two ganglia of each pair being closely bound together and each pair closely bound with every other by commissural fibres, each pair presiding over and regulating the changes occurring in its own segment of the body (the process going on being of the nature of a reflex action), one ganglion of each pair looking after its own lateral half of the segment, the connection of the ganglion with its lateral half-segment being effected by means of afferent and efferent fibres, the whole being fused and bound together into one apparently continuous structure. And this is the truth, though not the whole truth. The view just stated receives corroboration from the mere naked-eye inspection of the human spinal cord. It is not of uniform thickness throughout its length, but is markedly enlarged at the upper and lower ends. It is at the level of these enlargements that the nerves come off which supply the upper and lower limbs, and a microscopical examination of sections of the cord at these levels shows groups of nerve-cells particularly large and numerous. That is to say, to meet the requirements of the limbs there occurs a considerable multiplication of ganglia in the segments of the cord with which they are connected. Then a cross section of the cord appears to the naked eye to consist of two absolutely identical lateral halves, held together about the middle by a narrow connecting fibrous bridge.

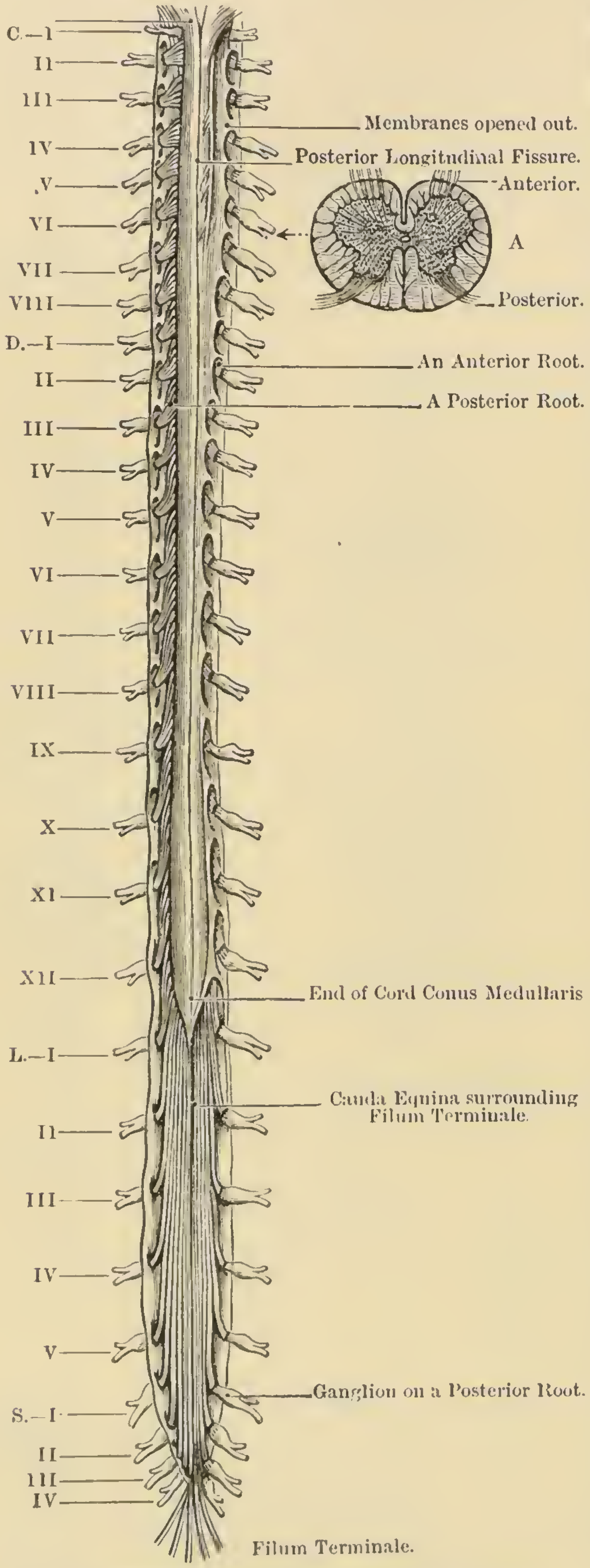


Fig. 93 —Representation of Human Spinal Cord—reduced.

C. I to VIII, Cervical Spinal Nerves. D. I to XII, Dorsal spinal nerves. L. I to V, Lumbar spinal nerves. S. I to IV, Sacral spinal nerves. A, In upper right-hand corner cross section of cord at level of 6th cervical nerve-roots.

Leaving, for the time, our consideration of the cord with this general understanding of the plan of its structure and of its functions, let us turn to the brain. Here again light is thrown on the subject by comparative anatomy and the anatomy of development. Even in some of the least-developed organisms there is a marked difference in size between the ganglion nearest the anterior extremity or head of the animal and the succeeding ganglia. Fig. 91 (p. 141) shows this, where the first pair of ganglia (G) are very large, and are so connected with the succeeding pair (S*g*) as to form a ring. Through this ring the gullet of the animal passes. This special development in this region is due to the necessity of nervous arrangements for the regulation of the means of introducing food into the body and of special organs, organs of sight, of hearing, tactile organs, and so on, and in these animals this ganglion is comparable in many ways to the brain of man and the higher animals. The anatomical similarity between this ganglion in invertebrate animals and the brain of vertebrates is readily seen when one compares such specially-developed ganglia of the highest invertebrates with the brain of the lowest vertebrates. Still more obvious becomes the similarity when one studies the development of the human nervous system. For in a very early stage of human development the nervous system consists of a straight tube of nervous matter running down the back portion of the body, that is, a spinal cord merely; and in the lowest vertebrate—the lancelet or amphioxus—there is no more than this, the anterior end of the cord being slightly swollen, representing the barest rudiment of a brain, being connected with a rudimentary eye and olfactory organ. As the development of the human embryo proceeds, the anterior end of the spinal tube enlarges into a bladder-like growth, which by constriction in two places becomes marked off into three, and these subsequently, by constriction of the first and third, into five little bladders or vesicles. These are the rudiments of what become subsequently developed into the fully-formed brain by expansion of parts and by growth of new material and thickenings in their walls (Fig. 94). As growth goes on, the tube is encroached upon until only a fine canal remains, still traceable in the fully-formed brain. At first the nerve tube is quite straight, but as development goes on it becomes bent, and the parts of the brain become folded upon one another, certain parts undergoing such rapid development as to overlap and cover other parts, so that at last the exceedingly complicated brain is produced, the relations of the parts of which it would be impossible to determine unless one were acquainted with its mode of development (Fig. 95). The brain, that is to say, is really an outgrowth from the spinal cord, constructed, to begin with, on the same type, consisting of ganglia with connecting fibres and with their respective ingoing or afferent and outgoing or efferent nerve tracts. This extension of the spinal cord is made to meet, in the first place, the demand for largely augmented nerve arrangements to supervise the great elaboration of structure and function that takes place within the very limited area of the head, that elaboration being connected with the varied and delicate movements of the face, of the jaws and tongue, and with the development, to a very high state of perfection, of special organs of sense connected with sight, hearing, smelling, taste. And indeed the cranial nerves, with the exception of the optic and olfactory nerves, are exactly comparable to the nerves coming from the spinal cord, the primitive type of which we have seen to be an afferent and efferent fibre connected with a nerve-cell in a ganglion. The ganglia of the cranial nerves, however, are not arranged in the brain in the same obvious orderly series as those of the spinal nerves, but become scattered and divided up by the great development of nerve structure that occurs in the brain.

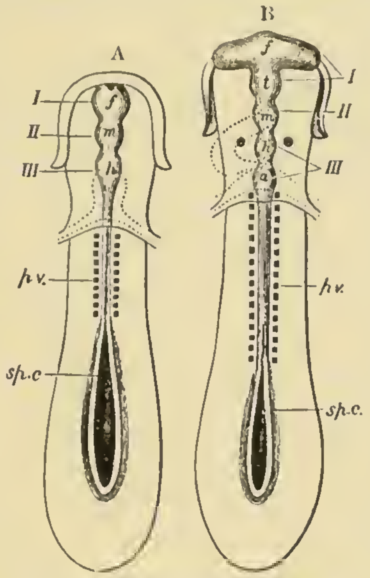


Fig. 94.—Development of Brain.

A, the stage of three primary vesicles. *f*, Fore-brain; *m*, mid-brain; *h*, hind-brain; *pv*, primitive vertebræ; *sp.c.*, spinal canal not yet fully closed in; I, II, III, the primary vesicles.

B, the stage of five vesicles. *f*, Fore-brain, and *t*, twixt-brain, from the first vesicle; *m*, mid-brain, second vesicle; and *h*, hind-brain, and *a*, after-brain, from third. Other references as in A.

To complete our physiological view of the building up of the brain certain other things must now be taken into account.

The process termed reflex action, which has been explained (p. 132), is sufficient to account for the various movements and changes which occur in the lowest organisms. Certain modified structures in or on the external wall of the animal are affected by changes in the medium in which the animal lives, and impressions are produced on them which, transmitted through the medium of nerve-cells, lead to movements of the animal. Similarly, changes in one part of the body of the animal lead by reflex action to changes in another part, and the close connection of nerve-ganglia with one another by commissural fibres ensures the co-operative action of the body as a whole. This does not imply any conscious perception, on the part of the animal, either of the stimulus applied to

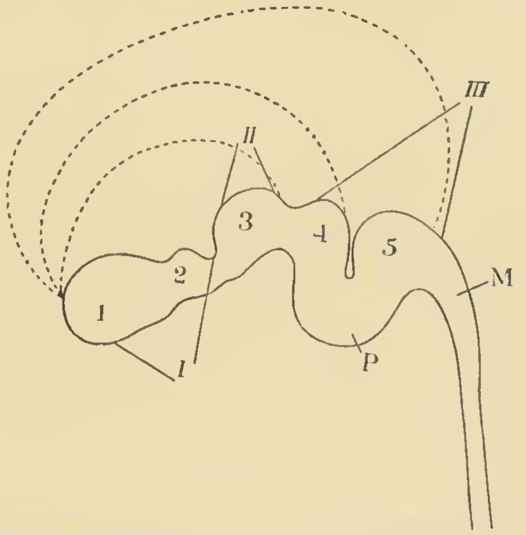


Fig. 95.—Stages in the Development of Cerebral Hemispheres from Fore-brain.

1, 2, 3, 4, 5 refer to the brain vesicles. I, II, III, are the parts forming the three primary vesicles. P, Pons Varolii. M, Medulla oblongata.

a part of the body or the change which it evokes. But in the higher animals this consciousness exists. Consciousness is undoubtedly a function of nerve structure, requiring a mechanism of nerve-cells, however impossible it is to understand how the activity of nerve-cells becomes transformed into a mode of consciousness, and it seems certain that some part of the brain is associated with consciousness. A blow on the head, or some disorder of the brain, may deprive a man of consciousness for the time, but still the functions of animal life go on, and reflex actions occur, showing that, while the functions of some of the higher ganglia are in abeyance, the remainder are unaffected. One might say that the blow or brain disorder had temporarily reduced the man to the condition of some of the lower animals. Here then, in the higher animals and man, is a new function, provided for by a special development in the brain. Now notice carefully what this implies. If an impression be made on some part of the body of a conscious animal, that impression would affect an afferent nerve and would pass, in the first place, to its connected ganglion, let us say in the spinal cord. If no interference occurred, it would excite a change in the ganglion in the cord, as the result of which an impulse would be discharged from the ganglion down an efferent nerve, and some movement or other change would result. But the animal is conscious of the impression, and the nerve-centres for consciousness are situated in the brain. This implies that the impression, besides reaching its proper ganglion in the cord, and setting agoing there the changes referred to, must have travelled up the cord along afferent fibres and reached a higher centre—the centre for consciousness in the brain. In the spinal cord of the higher animals and man, then, besides groups of nerve-cells constituting ganglia, and their commissural fibres, with the afferent and efferent nerves of each ganglion, there must be afferent tracts passing upwards to other ganglia in the brain, and these must be related somehow to the afferent nerves passing to the cord, and to the ganglia of the cord to which they pass.

Let us go a step further. We have said that reflex action is sufficient to account for the movements made by, and changes occurring in, the bodies of lower organisms. If such organisms were subject to no external impulses whatever, it is safe to assume they would remain motionless. But in more highly-developed animals changes are initiated by the animal itself, apart from any external impression, as well as in consequence of such external impressions. The animal, that is to say, is endowed with volition, or will, in a more or less developed form. This new capacity also requires a nervous mechanism which is situated in the brain, and by destruction or removal of a certain portion of the brain this capacity is lost, and the animal is reduced to the condition of a lower organism, requiring an external stimulus to set reflex action in operation and produce movement. For instance, if a frog be deprived of its cerebral hemispheres, "unless disturbed by any form of peripheral stimulus, it will sit for ever quiet in the same spot, and become converted into a mummy. All spontaneous action is annihilated. Its past experience has been blotted out, and it exhibits no fear in circumstances which otherwise would cause it to retire or flee from danger. . . . Surrounded by plenty it will die of starvation; but, unlike Tantalus, it has no psychical suffering, no desire, and no will to supply its physical wants" (Ferrier). Now the meaning of this is that, in such more highly-organized animals, certain centres exist in the brain which have the power of initiating impulses leading to movement. This implies that from these centres there proceed efferent nerve-fibres which, passing through the brain, descend the spinal cord, conducting impulses which, issuing from the cord, pass to muscles, exciting them to movement. It can be shown that these fibres descending from the brain are in some sort of communication with the ganglionic cells of the spinal cord, through which cells, indeed, the movements are effected. Thus the spinal cord consists of nerve ganglia united by commissural fibres. Each ganglion presides over a limited part of the body, receiving impressions from that part by afferent nerves, and exciting changes in that part by discharging impulses down efferent nerves, in response to the excitation brought by the afferent nerves. But in communication with the afferent nerves are other afferent fibres, which pass up the cord and carry the impression to centres in the brain, so that a consciousness of the impression arises. Also in communication with the ganglia are efferent fibres descending from centres in the brain, associated with volition. Thus, from the spinal cord ganglia, motor impulses may issue, either in consequence of an impression brought by an afferent nerve—that is reflexly—or in consequence of an impulse descending from the brain, as the result of an effort of will, initiated, that is to say, by the animal itself. Finally, to complete our general view, the higher animals are endowed with more or less intelligence, which in man reaches its highest development, including the faculty of memory, judgment, reason, imagination. These all require some nervous mechanism, and, humanly speaking, are inseparable from the activity of nervous structure, of nerve-cells. Only in a very rough way can the region of the brain, which is the seat of these operations, be indicated. Just as we have seen that in lower organisms the manifestation of higher functions is associated with increased complexity of structure, with increase in nerve-ganglia and their connected fibres, so are the beginnings of these higher mental operations associated with increased development of brain structure. The gradual evolution of these higher functions to more complete manifestations, as one passes from one animal to another higher in the scale, is accompanied by increase in brain structure and complexity. Upon the degree of development of the cerebral hemispheres depends the intellectual condition of the animal throughout the whole animal kingdom.

Let us now summarize the knowledge we have acquired of the functions of the central nervous system in man and the higher animals.

The spinal cord consists of a series of masses of ganglionic nerve-cells, disposed longitudinally and showing a bilateral arrangement. The masses are so close together as to be more or less fused, and are, besides, intimately connected with one another by communicating fibres. One or more ganglia presides over the functions of a part of its own lateral half of the body. With their own part the ganglia are connected, by afferent fibres carrying impulses to the ganglia from that part, and by means of efferent fibres impulses are discharged from the ganglia to that part, which regulate the changes in muscle, vessels, glands, &c., in the part, the ganglia being by this means reflexly excited to action. By the commissural fibres impulses conveyed by afferent fibres to one ganglion may extend to other ganglia, and lead to changes affecting other and more distant parts. The spinal cord, further, contains fibres which carry afferent impulses upwards to the brain, and these are in some sort of communication with the afferent nerves of the ganglion, so that the afferent impulse, besides rousing a reflex action, may reach the brain and become a conscious perception, may give rise to some kind of sensation. The cord also contains fibres which descend from centres in the brain, conveying efferent impulses to the ganglia, which excite them, and thus changes are brought about initiated by cells in the brain, not involving a reflex act.

The brain is partly a development of the same system that exists in the cord, having ganglionic masses with related afferent and efferent nerves, specially connected with the head and face and organs of speech. In it are developed, besides, ganglia related to the special senses of vision, hearing, taste, and smell. There also are developed the nervous mechanisms associated with feeling, thinking, willing, &c., and certain portions of its structure are more or less directly connected, by strands of fibres, with the afferent and efferent parts of the cord. By means of these strands the brain becomes a controlling influence to the reflex centres in the cord, consciously perceiving an afferent impulse which otherwise would only unconsciously excite a reflex act, and consciously initiating movements and other changes in the body, through the medium of the centres in the cord, which otherwise could only be called into action by a reflex stimulus.

FUNCTIONS OF THE SPINAL CORD AND SPINAL NERVES.

From what has been already said, we understand that the spinal cord consists of (1) a series of ganglionic masses of nerve-cells, each regulating, by reflex action through their related afferent or sensory and efferent or motor nerve-fibres, the actions going on in a part of the body, and (2) of strands of nerve-fibres conveying sensory impulses up to the brain, and motor impulses down from the brain. A few more details of these functions will now be given. First as to the spinal nerves.

Functions of Spinal Nerves.—Each spinal nerve arises by two roots (see diagram, Fig. 96). If one anterior root of one side be cut, there is loss of the power of movement in the parts supplied by the nerve, and changes in the blood-vessels and glands of the part; that is to say, by the anterior root impulses issue from the cord regulating the contraction of muscles, and controlling the blood-vessels and glands. In other words the anterior root is motor. If a posterior root be divided there is loss of sensation in the part supplied by the nerve, and no disturbance of movement. Stimulation of the upper end of the divided anterior root produces no result, stimulation of the lower end causes muscular movements. Stimulation of the upper end of the divided posterior root elicits indications of pain, while stimulation of the lower end produces no obvious effect. The spinal nerve is, therefore, a mixed nerve, containing both afferent or sensory and efferent or motor fibres. Along the afferent fibres impulses pass to the cord, entering its posterior portion, so reaching the ganglion cells, which, thus excited, discharge impulses by the fibres of the anterior root, at the front of the cord, down the nerve to muscles, vessels, and glands. Any injury of the anterior root which separates it from the cord is followed by degeneration—wasting and decay—of the motor fibres of the mixed spinal nerve below the seat of injury. So the course of these fibres can be traced to their ultimate terminations and distinguished from the course of the sensory fibres of the mixed nerve, which remain unaffected. This is because the fibres have been separated from their nerve-cells in the cord, which, therefore, besides their other functions, preside over the nutrition of the nerve-fibres of the anterior root. These nerve-cells are those of the anterior horn of the same side. Disease destroying these cells is followed by degeneration of the fibres of the anterior root issuing from them, and paralysis of the muscles supplied by them. On the posterior root is a ganglion (*g*, Fig. 96); division of the root outside of the ganglion is followed by degeneration of the nerve-fibres beyond and throughout the whole course of the mixed spinal nerve, fibres of the mixed nerve derived from the anterior root remaining unaffected. Division of the posterior root between the ganglion and the cord is followed by degeneration of the part left connected with the cord, and the degeneration may in time be traced right up the whole length of the cord in its posterior portion, while the part of the root left connected with the ganglion, and all beyond the ganglion, remain unaffected. The nutrition of the fibres of the posterior root is, therefore, presided over by the cells of the ganglion of the posterior root.

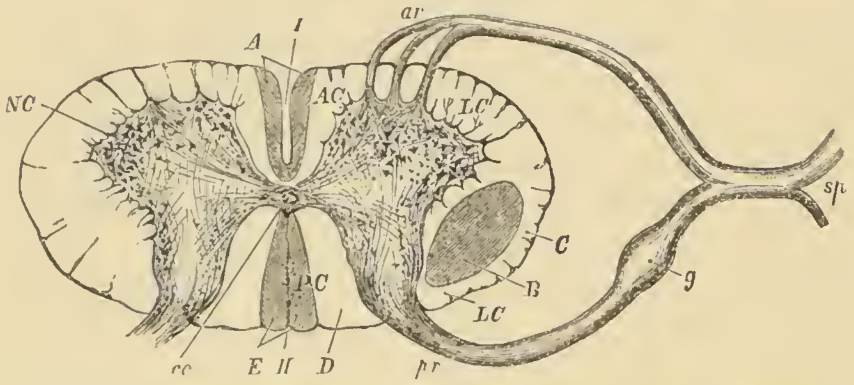


Fig. 96.—Cross Section of the Spinal Cord. Partly diagrammatic. Magnified.

I, Anterior median fissure. II, Posterior median fissure. *cc*, Central canal. AC, Anterior column (white matter). LC, Lateral column. PC, Posterior column, consisting of E, internal, and D, external portions. NC, Nerve-cells of anterior cornu. A, Direct pyramidal tract. B, Crossed pyramidal tract. C, Direct cerebellar tract. *ar*, Anterior root of spinal nerve. *pr*, Posterior root. *g*, Ganglion on posterior root. *sp*, Mixed nerve formed by the two roots dividing into an anterior and a posterior division to supply front and back of body.

Functions of the Spinal Cord.—Sensory or afferent impulses enter the cord by the posterior root. These impulses find their way to the cells of the anterior cornu of the same side, though no direct anatomical continuity has been traced between the fibres of the posterior root and the cells. The cells thus stimulated discharge impulses along the efferent fibres of the anterior root, which reaching muscles, &c., lead to movement. This is the reflex mechanism of the cord. The cells of the anterior horn give off numerous processes which branch, and are lost in the fine meshwork of the cord, but there is always one process of the cell which issues from the horn, and becomes the central or axis cylinder of a nerve-fibre of the anterior root, so that a motor nerve-fibre which reaches a muscle, and conveys to it a stimulus leading to contraction, is a direct continuation of a process of a nerve-cell in the anterior horn of the same side of the spinal cord.

As to the portions of the cord in which impulses are conducted *downwards from* the brain, and *upwards to* the brain, to put it broadly, motor impulses descend from the brain in the anterior and lateral columns of white matter, the white matter consisting of nerve-fibres running longitudinally in the cord, while sensory impulses pass upwards in the posterior columns. In the figure the shaded parts (A) bounding the anterior median fissure and the shaded part (B) in the lateral column are the tracts down which motor impulses descend from the brain, while the shaded parts (E) bounding the posterior median fissure, and the unshaded portions (D) on both sides between the fissure and the posterior roots, are the tracts up which sensory impulses pass to the brain, leading to sensation. If the anterior portion of the cord be cut through on one side, the parts below the section on the same side are paralysed as regards motion, though sensation is not disturbed; while if the cut involved the whole anterior portion of the cord the body would be paralysed on both sides below the level of the section. To put it in another way, motor impulses from the brain to the one side of the body, with certain exceptions that need not be further noticed, pass down the antero-lateral columns of the cord on the side to which they are distributed. As to the tracts of sensory conduction the facts are not so clear. If a posterior root (that is a tract by which sensory impulses enter to pass up the cord) be divided inside the ganglion of the posterior root, the part of the root connected with the cord degenerates, and the degeneration can be traced in the posterior columns right up the cord to the medulla, where it ceases, and always on the same side of the cord, never crossing to the opposite side. This would lead to the opinion that sensory impressions coming from one side of the body passed up the posterior column of the same side of the cord. On the other hand, cases of disease involving the posterior portion of half of the cord have been numerous in which sensation was diminished on the opposite side of the body. Thus injury or disease limited to one half of the cord, but involving both anterior and posterior portions, produces loss of motion on the same side of the body, and loss or at least diminution of sensation on the opposite side. This fact suggests that sensory impulses, entering the cord from one side of the body, soon after entrance cross and ascend to the brain on the opposite side. It may be noted that there are different sensations coming from the skin, sensations of touch merely, or of pressure, or of heat and cold, or of pain, and that from muscles there is a sensation of resistance, which is called the muscle sense. Certain facts seem to indicate that these various sensations pass upwards in the cord to the brain along different nerve-fibres running in the posterior columns, so that disease affecting limited areas of the spinal cord may destroy the conducting paths for one sensation, leaving the other tracts intact. For example, limited disease might destroy the conducting paths for sensations of pain, leaving intact the tracts along which sensations of touch, pressure, temperature, and muscular resistance pass. In such a case a pin thrust deeply into the skin would not give rise to a sensation of pain, but merely to one of contact.

CONNECTIONS BETWEEN THE BRAIN AND SPINAL CORD.

It will be useful here to note how the brain and spinal cord are connected. In the general view of the functions of the nervous system as a whole, it has been explained that before one can become conscious of an impression reaching the spinal cord, it must pass up the cord to a centre for consciousness in the brain, and that the impulse to voluntary movements begins in centres in the brain, and travels downwards to lower centres in the cord, through which the movement is ultimately effected. What is known about the pathways of sensory impulses up the cord to the brain, and of motor impulses down the cord from the brain? The spinal portion of the pathway has been noted above, we must now note the brain portion, and first the pathway of motor impulses, for these have been most clearly determined. In 1870 two German physiologists, Fritsch and Hitzig, discovered that the stimulation, by a galvanic current, of certain areas on the surface of the cerebral hemispheres gave rise to certain definite muscular movements. Since then a great many other observers, abroad and in this country, notably Dr. Ferrier of London, have repeated and extended these experiments. The results have been corroborated by the effects of disease, and a summary of the accepted facts will now be given.

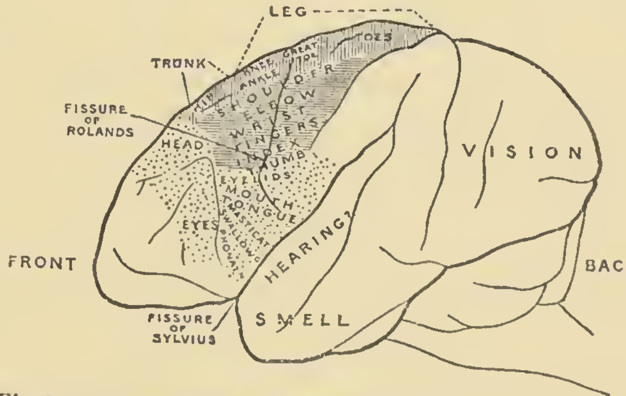


Fig. 97.—Left side of Brain of Monkey showing motor areas. See text.

Fig. 97 is a diagrammatic view of the left side of the brain of the monkey. A well-marked fissure, the fissure of Rolando, dips deeply into the brain substance, running downwards from the middle line above. Stimulation of small areas in the convolution in front of this fissure, and in the one behind, produce certain definite movements, and the diagram itself indicates the parts that are moved. Destruction of these areas leads to loss of power of voluntary movement of the specified parts, and from the destroyed area degeneration can be traced downwards through the brain and into the cord. That is to say, it is in the cells of these areas that impulses arise, when the person wills to perform the particular movement, and the impulse thus originated passes by efferent, *i.e.* motor fibres, through the brain and medulla oblongata to the spinal cord, down which it passes to reach the cells of the anterior cornu, from which efferent fibres proceed to the particular muscles to be moved. By means of the degeneration, which follows when any area has been destroyed, the pathway of the motor fibres proceeding from the area can be traced. Fig. 98 shows the median aspect of the left hemisphere when it has been separated from the right by a cut in the middle line from front to back, and it illustrates the fact that the **motor areas**, as they are called, are not limited to the outer side of the hemisphere, but are found also in the middle surface, the part next to the great longitudinal fissure (see p. 134). Now when the experiments are conducted on the *left* side of the brain, the movements occur on the *right* side of the body; when the *right* side of the brain is stimulated the movements occur on the *left* side of the body. When the explanation of this is sought, it is found that the motor fibres from the left side of the cerebral surface, after passing through the brain, reach the upper part of the spinal cord—the medulla oblongata—and there cross to the opposite side of the cord. The left side of the brain thus sends motor impulses to the right side of the body, and the right side of the brain to the left side of the body. Destruction of these areas, as has already been stated, causes loss of power of voluntary movement in the particular parts of the body they control, but, because of this crossing of fibres, destruction of the surface of the left side of the brain will cause paralysis on the right side of the body. These discoveries have been of infinite value in the treatment of disease. For, owing to them, in certain cases of paralysis of particular parts of the body or of convulsive movements of particular muscles, it is now frequently possible to determine the exact site in the brain of the disturbing cause, and surgeons have thus been enabled to open into the part of the brain indicated and successfully remove the growth, splinter of bone, or collection of matter causing the disturbance.

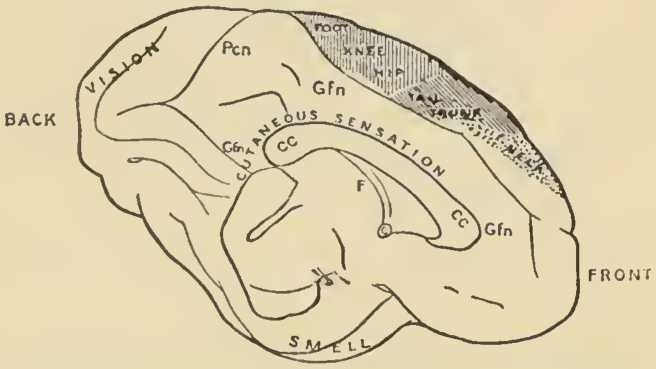


Fig. 98.—Middle internal aspect of Brain of Monkey showing areas of localized function.

From these motor areas the efferent fibres pass towards the base of the brain through the corpus striatum, thence through the crura cerebri and pons Varolii to the medulla oblongata. (These parts are described on p. 134.) When these fibres reach the medulla they form a well-marked strand, called the **pyramidal tract.** From each side of the brain there is a pyramidal tract. In the lower part of the medulla the tracts from each side cross one another, interlacing as they do so, so that the pyramidal tract from the right side of the brain crosses to the left side of the cord, and *vice versa.* This crossing is called the **decussation of the pyramids.** After crossing, the fibres pass down in the lateral column of the cord, forming the column of the crossed pyramidal tract (B of Fig. 96). Subsequently these fibres become connected with the cells of the anterior horn of the gray matter of the cord, and then from these cells other fibres pass off to the muscles. Thus when one wills to move the *right* leg, an impulse starts in an area on the surface of the *left* side of the brain, passes through the brain to the base, reaches the medulla, crosses there to the right side of the cord, down which it passes along fibres of the lateral column, till it reaches the lumbar enlargement of the cord. There it enters nerve-cells of the right anterior cornu of the gray matter, which it excites. In consequence, the cells discharge energy along fibres of the anterior root, down the nerves passing to the muscles of the right leg, which thereupon contract, and the leg is moved. All the fibres of the pyramidal tract do not pass from one side to the other in the medulla; a few fibres pass down the cord on the same side, but ultimately cross in the cord. These fibres form a strand in the cord called the uncrossed or direct pyramidal tract, A in Fig. 96. It is not so easy to trace the course of sensory impulses up the cord to the brain. But it is known that such impulses pass up to the medulla, where they may reach nerve-cells, from which by other afferent fibres they may pass to the cerebellum or through the pons and crura to the cerebral hemispheres. In some part of their course sensory impressions cross like motor impulses from one side to another. Experiments have been directed to discover where the centres for the perception of sensations are situated in the brain, and the results are indicated in the diagrams (Figs. 97, 98). It is sufficient to say that though the areas in the brain for the conscious perception of sensory impulses have not been so accurately defined as the motor areas, the evidence is conclusive that definite groups of nerve-cells in the cerebrum are set apart for receiving all the varieties of sensations, and that if any of these areas be destroyed the power of perceiving the particular sensation is lost.

LOCALIZATION OF FUNCTION IN THE BRAIN.

(Plate XI.)

From the facts which have been explained it will be understood what is meant by the phrase localization of function in brain and spinal cord. The brain and spinal cord do not act as a whole in the multitudinous variety of nerve operations. One part of the brain or spinal cord—one group of nerve-cells—is set apart for one duty, another group for another duty, so that a particular function is limited to a particular group or groups of nerve-cells — the function is localized.

These modern views of the localization of function in small areas of nervous substance are fitted to rouse grave reflections. We know that it is true of a muscle that moderate and regular exercise of it conduces to its increased development and power. It is by constant exercise that the arms of those accustomed to manual labour are so strong and well formed. Further, we know that want of use causes a muscle to waste. An arm put up in splints for six weeks for fracture is much thinner than its neighbour at the end of that time, just because of its enforced idleness. *Proper use increases strength, want of use weakens.* There is no manner of doubt that these rules apply to the nervous system. Everybody knows that a man who regularly studies music becomes by and by more or less of an adept at his art; everybody knows that the man who fitfully studies anything shows evident signs of his neglect. Now the application of these rules to what has been said about special centres in the brain means that the systematic use of any faculty of the mind develops and strengthens the nerve-centre that presides over that faculty, and that disuse means waste of the nerve-centres. Thus, to put it broadly, a man may be supposed to be born with a brain that may be thought of as a series of nerve-centres; these various centres have the *capacity* of being trained to discharge certain duties; if the training be given, the centres will be developed, and the man will be able to perform the duty; if the centres be not trained they will degenerate and decay, and the man will be unable to perform the duty. People excuse themselves for defects of education, or other defects, by saying, "I have no head for this," "I have no faculty for that." This translated into stricter language would be, "I neglected to develop the capacity I once possessed, and it, consequently, has gone to waste."

The time for developing nerve-centres, for training or educating them, is naturally during the period when growth is possible, that is, in youth.

For if the nerve-centres are not exercised during the growing period, their development will not take place; and when the growing period is passed the risk of development being impossible is great.

A word of caution is necessary. While what has been said is an argument for an all-round training, a training of eye and ear, tongue and hand—training of every muscle of the body as well as of every faculty of the mind,—it must not be taken to sanction overburdening and overstraining of nerve-centres. The runner training for a race does not begin at once to go at full speed for his full distance. He takes short distances at first and leisurely to accustom his muscles to their work, and he gradually goes farther and faster, always avoiding exhaustion. So the training from the youth up should be prudent and regulated with a watchful care against over-work. For overexertion and over-stimulation are as ruinous as neglect.

Phrenology.—The view that certain little areas of brain substance are connected with certain functions is not to be confounded with phrenology, which maps out on the outside of the skull certain regions said to be devoted to certain emotions, &c., the prominence of the regions indicating the amount of development of the faculty, emotion, &c. The brain exhibits no such divisions as phrenology creates, still less can any prominence or depression on the outside of the head indicate, through scalp and bones, the shape of that part of the brain within. The phrenological theory was first propounded by Gall and Spurzheim in the beginning of the past century.

FUNCTIONS OF THE VARIOUS PARTS OF THE BRAIN.

The Functions of the cerebral hemispheres have been already indicated. They are associated with mental phenomena—feeling, thinking, and willing, and with all conscious states. They are the seat of intelligence. An animal deprived of the cerebral hemispheres is only a very complicated mechanism, but a mechanism incapable of starting itself, though, when stimulated by some impulse from without, capable of as great a variety of complex and co-ordinated movements as an animal endowed with intelligence. But it is nevertheless only an elaborate mechanism, without consciousness, and incapable of spontaneous action. From the cerebral hemispheres originate all voluntary movements, through the cells of the motor areas, and only when sensory impulses reach them do these impulses rise into consciousness.

The **corpora striata** are concerned in the transmission downwards of motor influences, that is, nervous impulses which excite muscular contraction. Injury or disease causes paralysis of motion on the opposite side of the body, the motor fibres crossing in the medulla. Motor impulses do not originate in the corpora striata, but these organs receive the impulse from the higher centres in the cerebrum and transmit it downwards. Again, they may be concerned in reflex movements without consciousness. Thus a nervous impression, starting from the eyes, reaching the corpora quadrigemina, is probably transmitted forwards to the corpora striata, and thence passes downwards to excite muscular contractions.

The **optic thalami** are sensory centres receiving impressions, probably those of touch, and transmitting them upwards to the cerebral hemispheres, where they may arouse consciousness. Injury or disease of these organs on one side causes loss of sensibility, or disordered sensibility, on the *opposite* side of the body, as the majority of sensory fibres cross from one side to the other in some part of their course. Just as the corpora quadrigemina are the recipients of *visual* impressions which may result in such complex muscular movements as those of walking without consciousness, so the optic thalami perform the same functions in relation to impressions of touch.

The **corpora quadrigemina** are connected with the sense of vision and with the movements of the pupil. Disease or injury causes dilatation of the pupil and blindness. The corpora also receive visual impressions which may be transmitted upwards to the cerebral hemispheres, resulting in a sensation of light; or they may cause co-ordinated or regulated movements without sensation. Thus visual impressions may cause well-regulated movements without the person being actually conscious of what he sees, as happens in somnambulism.

The **pons Varolii** contains motor and sensory fibres passing downwards and upwards, and, in addition, it contains centres of gray matter which are connected with the roots of some of the cranial nerves (Fig. 85, p. 135). Irritation of the pons causes very severe convulsive spasms. The pons also contains, as already stated, transverse fibres connecting one half of the cerebellum with the other half, thus securing co-operation between the two portions, but the exact way in which this is done is unknown.

The **cerebral peduncles** or **crura**, seen immediately in front of the pons in Fig. 85, contain both sensory and motor fibres. The sensory are in the back part of the peduncles, and pass upwards to the corpora quadrigemina, optic thalami, and posterior lobes of the cerebrum, whilst the motor fibres pass downwards from the corpora striata in the fore part of the peduncles. Injury to one peduncle sometimes causes an animal to move to the side opposite the injury, so as to describe a circle, somewhat in the manner of a horse in a circus.

The **cerebellum** is the regulator or co-ordinator of muscular movements. The mechanism by which it does so has not yet been satisfactorily explained. It receives nervous impressions connected with sight from the corpora quadrigemina, connected with touch by nerve-fibres coming from the skin and passing up the back part of the spinal cord, and also impressions associated with the sense of equilibrium by the nerve of hearing from the semicircular canals in the ear. (See Ear.) Disease of the cerebellum in the human being is rare, but when it does exist there is usually blindness, a dilated pupil, giddiness, a tendency to move backwards, and a staggering irregular gait. There is no loss of consciousness or other disturbance of the mental functions.

The **medulla oblongata,** connecting the spinal cord with the brain, may be regarded as a great nervous tract for transmitting sensory and motor impressions, and also as the seat of a number of centres for reflex actions of the highest importance to life. Motor transmission.

that is the transmission of nervous influences from above that result in contractions of muscles in some part of the body, occurs chiefly at the fore part of the medulla. Here also many of the motor fibres *cross from one side to the other*, as already explained (p. 148). Through the medulla sensory impressions also pass, that is, impressions from below upwards, from the surface of the body to the brain, resulting in sensation or feeling; but their route is not accurately known.

The medulla is remarkable for being the seat of a number of reflex centres connected with the movements of the heart, the movements of respiration, the influence of the nervous system on the blood-vessels, the movements of swallowing, and the secretion of saliva. In addition, it is at least partly the origin of many of the important cranial nerves (p. 135). Consequently, injury to this part of the nervous system is quickly fatal, and in nervous diseases, or towards the close of life, when the power of swallowing is lost, we may infer that the medulla has become affected.

THE CRANIAL OR CEREBRAL NERVES.

There is a set of nerves, called the cranial or cerebral nerves, which pass from the brain through different openings in the skull, and are distributed over the head and face as well as to some parts of the trunk and certain of the internal organs. The nerves come off in pairs, one from corresponding parts of each side of the brain. Fig. 85, which represents the base of the brain, shows the places where these nerves issue from the brain substance. Reference should be made to that figure and to the description which accompanies it.

1. The first pair is the **olfactory**. They are bundles of very delicate nerve-filaments which come off from the olfactory bulbs which lie under the front lobe of the cerebrum. They pass down into the nasal cavity through the ethmoid bone. They are nerves of the special sense of **smell**. (See Sect. XXII., SMELL.)

2. The second pair of nerves is devoted to the sense of **sight**. They are the **optic** nerves, and pass forward into the cavity of the orbits to reach the eyeballs. (See Sect. XXII., SIGHT.)

3. The third pair are motor nerves, also passing into the orbits to supply the muscles of the eyeball. They are the nerves of motion for the muscles that turn the eye upwards, downwards, and inwards, and for the muscle that lifts the upper eyelid. They also supply the iris, that is, the circular curtain of the eye, by whose contractions the pupil of the eye is made larger or smaller. They leave unsupplied the muscle that turns the eye outwards, and another that turns it upwards and inwards. Thus, suppose this third nerve to be paralysed, the eye could not be turned upwards, or downwards, or inwards, but would be wholly under the influence of the two muscles already mentioned as independent of the third nerve. The eye would thus, by these two muscles, be kept drawn downwards and outwards. The upper eyelid would also be paralysed, and would droop over the eyeball and could not be lifted, while the pupil would be very large and immovable. It is obvious, therefore, that one eye would squint very much, and there would be double vision, two objects would be seen for one, owing to the want of united action between the two eyes.

4. The fourth pair of nerves is called the **pathetic** pair, because the nerves supply that one of the muscles, omitted by the third pair, whose contraction gives the upward turn to the eyes which we call pathetic.

5. Each one of this pair of nerves is in three divisions, and proceeds mainly to the face. It is therefore called **trifacial**. They are mixed nerves, partly sensory and partly motor. The first division, however, is purely sensory, and passes into the eyeball, on which it confers sensibility. The second division is also purely sensory, and gives sensation to the nose, and gums, and cheeks. The third division is partly sensory and partly motor. Its sensory branches confer sensibility for taste on the front two-thirds of the tongue, and ordinary sensation on the inner side of the cheeks and on the teeth, and also the scalp in front of the ear. Its motor branches supply the muscles of mastication (p. 113). Thus paralysis of the fifth pair of nerves would destroy the sensibility of the eyeball, and would, moreover, cause ulceration and inflammation to appear in it, would destroy to some extent the sense of smell and the sense of taste, would abolish sensation from the skin of the face, and would cause paralysis of the muscles of mastication, so that the movements of chewing would not be performed. If paralysis occurred to the nerve of one side only, that side of the face and tongue would be deprived of feeling, and the muscles of that side of the jaw being palsied the jaw would be wholly under the control of the opposite side, and would be pulled to the other side, so that the upper and lower teeth would not correspond.

6. The sixth pair is called the **abducent** or abducting pair of nerves, because they are motor nerves and supply the muscle that abducts or turns the eye outwards. This muscle was omitted by the third pair. Paralysis of the nerve leaves the eyeball under the influence of the opposite muscle, namely, that which turns it inward, so that the eye has an inward squint.

7. In each of the seventh pair of nerves there are two portions: the one called **portio mollis** (soft portion) is sensory, and is the **auditory** nerve—the nerve of hearing (see Sect. XXII., HEARING); the other, called **portio dura** (hard portion) or **facial** nerve, is motor, and supplies the muscles of expression. Thus paralysis of the auditory portion would produce deafness; paralysis of the facial would produce palsy of the muscles of the face. The result of facial palsy is that the affected side is smooth, unwrinkled, and motionless; the eyelids, being also palsied, are wide open and cannot be closed; and the face is wholly under the control of the muscles of the opposite side, which, having it all their own way, drag towards that side, so that the mouth is pulled away round. Refer to FACIAL PALSY, p. 177.

8. The eighth pair is very complex. The eighth nerve of each side consists of three trunks which arise from the medulla oblongata, and leave the brain by one opening.

The first trunk is called **glossopharyngeal** (*glossa*, the tongue, and *pharynx*, the throat) because it supplies the throat and back part of the tongue. It is partly sensory, conferring taste on the back part of the tongue, and partly motor.

The second trunk is the **pneumogastric** (Greek *pneumōn*, the lung, and *gastēr*, the belly) or **vagus** nerve. It is both sensory and motor. Passing from the medulla it descends on the gullet to the stomach, sending off, on its way, branches to the throat, the box of the windpipe, lungs, and heart. Paralysis of one of its branches causes loss of voice; some of its branches exercise a restraining influence on the movements of the heart, others convey messages to the brain, which result in quickening or slowing movements of breathing; while by means of the branches passing to the stomach impressions are conveyed upwards to the brain which inform us of the condition of the stomach, and are the means by which we experience feelings of hunger, nausea, pain in the stomach, and many other indefinite sensations which we associate with that organ.

The third trunk of the eighth pair is the **spinal accessory**. It is a motor nerve; part of it, the accessory part, joining the pneumogastric, and part proceeding to two muscles, one of the neck, the sterno-mastoid, and the other of the back, the trapezius.

9. The ninth pair of nerves is the **hypoglossal** (*hupo*, under, and *glossa*, the tongue). It is a motor nerve, and passes along the under surface of the tongue to its tip. Paralysis of the nerve of one side renders that side of the tongue flaccid, and on putting the tongue out of the mouth it will be pushed out with its tip towards the affected side. Paralysis would also cause difficulty of speech, and difficulty of swallowing owing to the tongue not being able to perform the first act of swallowing, namely, push the food to the back part of the mouth.

THE SYMPATHETIC SYSTEM OF NERVES.

At each side of the backbone, from the base of the skull to the coccyx, there is a chain of swellings. These are the ganglia of the sympathetic system, and there are twenty-four or twenty-five of them on each side. The ganglia of one side are connected together by fibres running between them, while fibres also pass from the trunk of the nerve to the spinal nerves in the neighbourhood. At the coccyx the two chains unite in a single ganglion. At the upper end the trunk of each side passes up into the skull and becomes intimately connected with the cranial nerves. In the neck branches pass from the chains of ganglia to the lungs and heart. From the ganglia in the chest three nerves pass off, called the **splanchnic** nerves, which together form a complicated net-work or plexus of nerve-fibres in the upper part of the belly. From this sympathetic plexus branches pass along blood-vessels to the stomach, liver, intestines, kidney, and other abdominal organs. A similar net-work of sympathetic fibres is situated lower down in the pelvis, from which branches pass to the pelvic organs. Thus in general the sympathetic system of nerves, while found intimately connected with the cerebro-spinal system, is found specially accompanying blood-vessels and supplying the glands and viscera, that is, the hollow organs of the body.

Functions of the Sympathetic.—These nerves are specially connected with the processes of organic life, the movements of the heart and of respiration, the work of the stomach and bowels in digestion, the process of secretion in glands, and so on. The impulses that proceed along the sympathetic nerves are not subject to voluntary control, and thus all those actions that have been mentioned that are necessary to the life of the body and the harmony that evidently subsists between the internal organs, which unites their action to one end—the maintenance of the animal life,—are affected by the sympathetic system. One special function of this system is the control of the blood-vessels. By means of nerves distributed to the muscular coats of the arteries the width of these vessels can be varied so that at one moment they will permit a large quantity of blood to pass to a part, and at another moment will contract so as to diminish the supply. This also is beyond the control of the will, and is effected by the sympathetic through a reflex arrangement the centre for which is in the medulla oblongata. This will be explained in more detail in the section on the circulation of the blood.

THE DISTRIBUTION OF NERVES.

The distribution of the cranial nerves has been already indicated. Each spinal nerve, after it has issued from its opening in the backbone, splits into two divisions, one of which proceeds to supply parts behind the spine, while the other passes forward towards the front. The first eight spinal nerves on each side are called **cervical**, the next twelve are **dorsal**, the next five **lumbar**, then five **sacral**, and one **coccygeal**. The front divisions of the first four cervical unite to form what is called the **cervical plexus**, from which branches are supplied to the muscles of the neck. One very important nerve springing from the group is called the **phrenic**, which passes down the front of the chest to supply the diaphragm or midriff, upon the movements of which breathing so much depends. The other four of the cervical nerves and one of the dorsal unite to form the **brachial plexus**, from which nerves proceed to the upper limb. They enter the arm from the arm-pit, which they cross in company with the large blood-vessels for the limb. One of them winds round a groove in the upper arm-bone and passes to the muscles of the back of the arm. It is called the **musculo-spiral** nerve. A second, the **ulnar** nerve, descends on the inner side of the arm. At the elbow it rests in an interval between the inner projecting process of the arm-bone and the point of the elbow. When the elbow is knocked at this place the shock given to the nerve produces the sensation ascribed to "knocking the funny bone". The nerve passes to supply the little finger and the neighbouring side of the ring-finger. If these two fingers become numb, therefore, it is due to paralysis of this nerve. The remaining fingers and the thumb side of the ring-finger are supplied by the **median** nerve, which passes down the middle of the arm. All these nerves are *mixed*, that is, they confer power of motion and sensation.

Of the twelve **dorsal** nerves the posterior divisions supply the muscles and skin of the back, the anterior divisions supply branches, called **intercostal nerves**, to the spaces between the ribs.

The five **lumbar** nerves also send their posterior branches to the back; while the anterior divisions of the first four unite to form a group called the **lumbar** plexus. From it branches pass to the belly and genitals, and large branches to the muscles of the front of the thigh, and to the skin of the front and inner side of the thigh, and to the skin of the inner side of the leg and foot.

There is also a **sacral** plexus, formed by the anterior divisions of the sacral nerves, reinforced by the last lumbar.

From this group proceeds the largest nerve in the body, the **sciatic** nerve—a neuralgic affection of which is called sciatica. It gives branches to the muscles at the back of the thigh, and branches also to muscles below the knee, and to the skin of the leg and foot. The nerve escapes from the pelvis just outside of the seat bone, and passes right down the middle of the back of the thigh till the back of the knee-joint is reached, where it divides into two branches called **internal** and **external popliteal**. The first of these branches continues the main course down the back of the leg, where it is called **posterior tibial**. It divides on the inner side of the heel into two branches, which between them supply the sole of the foot and the sides of the toes. The external branch turns round below the knee to the front of the outer side of the leg, down which it passes as the **anterior tibial**, supplying muscles on the way, and ends in branches to the skin of the back of the foot.

SECTION IX.

THE NERVOUS SYSTEM.

ITS DISEASES AND INJURIES.

Diseases and Injuries of the Brain:—
- *Inflammation* (1) of membranes (*meningitis*), tubercular inflammation, (2) of the brain itself (*cerebritis*);
- *Softening; Dropsy* (*hydrocephalus, water in the head*);
- *Congestion; Apoplexy; Anæmia;*
- *Coma, Compression* and *Concussion* (shock);
- *Abscess* and *Tumour;*
- *Delirium Tremens*—dipsomania;

Insanity—
- Its Causes, Symptoms, Kinds (*Melancholia, Hypochondriasis, Mania, Monomania, Paranoia, Dementia, Dementia Praecox, Idiocy, General Paralysis of the Insane*), Prevention and Treatment.

Prominent Nervous Symptoms:—
- *Headache* and *Giddiness* (*vertigo*).
- *Somnambulism, Sleeplessness, Nightmare, Neurasthenia.*

Diseases and Injuries of the Spinal Cord:—
- *Inflammation, Degeneration, Congestion, Spinal Irritation, Concussion, Spina Bifida.*

Paralytic and Convulsive Diseases:—
- *Paralysis of Motion*—Hemiplegia, Cross Paralysis,
  - Paraplegia, Aphasia,
  - Local Paralysis—facial palsy,
  - Locomotor Ataxia, Shaking Palsy, Wasting Palsy, Pseudo-hypertrophic Paralysis, Infantile Paralysis, Lead Palsy.
- *Paralysis of Sensation;*
- *Convulsive Diseases*—Convulsions, Epilepsy, St. Vitus Dance, Tetanus, Tetany.

Diseases and Injuries of Nerves:—
- *Inflammation of Nerves;*
- *Multiple Neuritis; Beriberi;*
- *Neuralgia and Sciatica.*

DISEASES AND INJURIES OF THE BRAIN

Disease of the brain may attack the brain substance itself, or it may affect the membranes, pia mater, arachnoid, and dura mater, which envelop it, or it may be situated chiefly in the cavities—ventricles—of the brain and their neighbourhood.

INFLAMMATION, SOFTENING, AND DROPSY OF THE BRAIN

Inflammation of the Membranes of the brain is called **Meningitis.** It may be due to injury, to sunstroke, or to excess in alcohol, but in the vast majority of cases it is due to the irritation of a poison. The poison may have gained entrance by a wound, due to a blow for instance, or it may have gained admission from one or other of the cavities of the head or face. A suppuration of the nose, for instance, or of the ear, or in the orbit, or throat may extend gradually till it reaches the brain. Such an inflammation would be called septic. But the poison might reach the brain in the blood stream. This occurs, there is no doubt, in scarlet fever, erysipelas, influenza, typhoid fever, pneumonia, in syphilis, and in general blood-poisoning. Such cases might be called toxic. In the septic form the poison is in the shape of a living organism, such as is described in the section on infection (p. 493), in the toxic form it may be a living organism or it may be a quality of blood.

Now there are two organisms which may reach the brain and are responsible for nearly all the cases of inflammation, one is the organism of pus, of matter, suppuration in general, and the other is the organism of tubercle (see p. 501). The organism of pus reaches the brain from the ear or other cavity of the face, and tubercle is disseminated in the blood stream. The tubercular form will be considered by itself. *One of the most frequent causes of septic meningitis met with in practice is old standing disease of the ear.* The patient may have suffered for years from a "running at the ear." All the time the disease is slowly finding its way to the brain, and not infrequently the sudden stoppage of the discharge is the first occurrence in the attack.

Symptoms.—Severe and constant pain in the head, now and again becoming unbearable, is very common. Sudden giddiness and vomiting may occur. Light painfully affects the eyes. There is fever, and often delirium, which sets in early, and may be violent or muttering, and sometimes convulsions, specially in children. The pulse may be quick but it is often unusually slow. These are in general the kind of symptoms, though they vary considerably. The disease is very serious, and may go on to intense prostration, when the excitement ceases and unconsciousness comes on. It may end in death within two or three days, or not till two or three weeks.

Treatment.—Every effort must be made to discover any source of infection about the head, in the ear, nose, &c., as if such were found some surgical procedure might be necessary for its removal. Should the bone behind the ear be tender, a blister or leeches should be applied there at once, though bleeding by a cut down to the bone at that place is best if a surgeon be at hand to perform it. If a discharge from the ear has existed, it may be well to apply large hot poultices over the ear, besides using the blister.

The bowels must be freely moved by repeated small doses of calomel, $\frac{1}{8}$ grain every hour till a good result is obtained. Iced cloths to the head allay fever and excitement. The rest of the treatment is as suggested for the tubercular variety.

The **tubercular** form is so called because in it little nodules or tubercles are found after death in the membranes at the base of the brain. It has also been called **acute hydrocephalus, that is, acute water in the head,** because much fluid is found in the cavities of the brain, and softening of the surrounding brain substance. It is not uncommon in children under five years of age. The character of tubercle is pretty fully described on pages 375 and 551.

Symptoms.—The child attacked often shows signs of general ill-health for weeks before the disease is fully developed. The principal of these early signs are peevishness and restlessness, weakness, and falling off in health. *A very suspicious early sign is sudden vomiting without sickness and without any apparent cause.* The child may be wakeful at night, grinding its teeth and starting up in bed screaming. There may be also feverish turns. When at length the disease is fully developed it unfolds itself in three stages. *In the first stage* the child is highly fevered, with rapid pulse. It suffers from headache, which makes it scream out at intervals, and it is distressed by slight noises and by light. The bowels are usually confined. There is sometimes delirium. *In the second stage* the excitement ceases, and the child lies quietly, is with difficulty roused to say anything or to take food. He is indifferent to everything, and perhaps passes water and motions without knowledge. At intervals he utters a very peculiar, distressful, shrill, plaintive cry, which is characteristic of this disease, and convulsions may occur. His hands wander aimlessly about, picking the bedclothes, or his nose and lips. *In the third stage* he becomes quite unconscious. *The pupils of the eyes are very wide, and do not contract when a light is brought near.* This stage may come on slowly or suddenly after a fit of convulsions. The pulse gets feeble and the skin cold and clammy. The child may die in a convulsion, or simply slip away. Death may occur within a few days, but frequently not for two or three weeks.

Treatment seems of little value in this disease, yet rare recoveries have taken place in cases presenting all its symptoms.

1. Place the patient in a quiet, darkened room, well ventilated and kept at a moderate warmth, and let the person be kept warm by flannel clothing if necessary.

2. Relieve the constipation of bowels by calomel and jalap (Prescriptions), or castor-oil. If these fail, injections of castor-oil and hot water, or hot water and salt (see p. 592), may succeed. 3. Give fluid nourishment—milk, beef-tea, &c. 4. The headache may be relieved by iced cloths. 5. To relieve the excitement and diminish the tendency to convulsions give to a child 5-grain doses of bromide of potassium dissolved in a little water every three hours; an adult may get 30-grain doses. If recovery should take place, pure milk, cod-liver oil, and sea air will greatly aid it.

If one child out of a family has died of this disease, pains should be taken with the other children to ward it off from them, and unceasing watchfulness for the earliest indication of the affection should be exercised till the child is seven years of age. The children should be permitted no excitements; their studies should be neither long-continued at one time nor severe; they should have early hours, have well-ventilated rooms in some healthy locality, and good nourishment. They should also have a course of cod-liver oil and tonics.

Inflammation of the Brain itself (*Cerebritis*) is not easily, if at all, distinguishable from inflammation of the membranes. Usually both brain and membranes are attacked together.

The **symptoms** are similar to those already described—fever, hard irregular pulse, constipation, sickness, and vomiting. There are also severe headache, impatience of light, confusion of thought, and perhaps delirium. These are followed by stupor, dulness of sight and hearing, perhaps squinting, and sometimes convulsions. The disease may begin its course in a long convulsion, and the convulsive seizures may end in paralysis or deep unconsciousness—coma as it is called.

The **treatment** consists largely in administering strong purgative medicines, such as calomel and jalap (see Prescriptions). Also for a full-grown man bromide of potassium in 15- to 30-grain doses every five hours, and iodide of potassium in 3-grain doses every four or six hours may be given to diminish if possible the inflammation and excitement. The head should be shaved, and iced cloths applied. Mustard foot-baths are sometimes used; also mustard blisters to nape of neck (the benefit from which is doubtful) and bleeding. The latter should never be employed unless by medical advice. Milk diet is to be given; and if exhaustion sets in, strong beef-tea and stimulants of ammonia, wine, or brandy may be required.

Softening of the Brain is sometimes a consequence of inflammation, but is oftener due to want of proper circulation of blood, and is therefore more common in old and feeble people. A frequent way in which a region of the brain may be deprived of its due supply of blood is by a small clot being carried, in the current of blood, from the heart diseased on account of rheumatism. The clot passes along the larger blood-vessels quite safely, but sticks when it reaches the narrower vessels of the brain. It, therefore, blocks the vessel and prevents the blood passing on to that district which the vessel supplied by itself and its branches. The clot which acts thus as a plug is called an **embolus**, and the disease is said to be **embolism**. The region of brain thus deprived of blood becomes soft and breaks down.

The **symptoms** of such a case of sudden occurrence are loss of power of one side of the body—the opposite side to that on which the disease of the brain exists. The loss of power is sudden and may be without loss of consciousness. Complete or partial recovery may take place. Oftener recovery will not take place, but the intellect gets impaired, and the person childish and feeble, surviving in that condition for some time, and finally becoming unconscious, and death resulting. Softening of the brain may occur more slowly and be accompanied by such signs as weakening of intellectual powers and loss of faculties, depression of spirits, and tendency to weep at any small excitement, pain in the head and giddiness, pain or prickings, and twitchings of the limbs. These may end in sudden paralysis, as already described. Treatment of such disorder is of course impossible. The person must only be kept quiet, and must receive food easy of digestion, costiveness being guarded against.

Dropsy of the Brain is also called **chronic hydrocephalus** or **chronic water in the head**. (For acute hydrocephalus see previous page.) Its most common forms occur in childhood. The child may be born with the disease, as shown by the very large head, which often hinders delivery, or the disease may arise after birth, generally before the child is six months old. It is due to an increased amount of fluid in the cavities—ventricles—of the brain (see p. 135). Sometimes the disease takes the form of a tumour, attached to the back of the head generally. The cavity of the tumour communicates with the cavities of the brain, and may contain part of the membranes and fluid, or even part of the brain itself. The communication is usually by a small opening in the occipital bone (p. 59).

In the commoner forms there is simply an increasing quantity of fluid in the cavities of the brain. As the fluid increases the head enlarges, specially at the sides and upper parts. The bones of the skull separate from one another, the intervals between them being at first only covered by the scalp. The head may increase enormously so that the child cannot keep it up without supporting it with its hands, the forehead, sides, and back all protruding, and the top being flattened. The skin is thinned by stretching, and the blue veins are seen through it. The eyeballs seem to protrude owing to the stretching upwards of the eyebrows and lids, while the face is very small and thin in proportion to the large head, and the body is small and badly developed. The child is liable to convulsions, loss of sight and hearing, and intelligence, while it may become fretful and passionate. Occasionally, however, intelligence remains good. Such children frequently die at birth; they may survive to the second year or later, and die of convulsions or other disease. They may even live to a good age. If they survive, bone forms slowly to fill up the gaps left owing to the separation of the usual cranial bones. In a few cases the disease ceases, and leaves the child with large head and small face, and development otherwise diminished to a greater or less extent.

No treatment is of any avail. Strapping the head to prevent it growing, piercing it in safe places to withdraw some of the excess of fluid, and all such practices have been abundantly proved useless. Medicines, too, fail, iodide of potassium, iodide of iron, and mercury, those that might be supposed useful, among the number. Probably simple attention to the child's diet, and to the state of its bowels, and the use of cod-liver oil or iron tonics, is as good treatment as any.

CONGESTION AND ANÆMIA OF THE BRAIN.

Congestion or excess of blood to the brain may arise because too much blood comes to the brain, or it may be because, owing to some obstacle, the blood is not permitted to return from the brain with due rapidity and ease. Thus wearing tight things round the neck will hinder the return of blood. Congestion is likely to occur in florid, full-blooded people, given to high living without sufficient exercise to work it off. *Constant tippling is very likely to produce it.* It may also arise from disease of other organs, especially the liver, heart, and kidneys.

The **symptoms** are a sense of fulness and tightness of the head, flushing of the face, noises in the ears, motes dancing before the eyes, headache, giddiness, sickness, dulness, &c. Even unconsciousness may be produced and convulsions. The symptoms indeed may go on till the condition of **apoplexy** is produced, when the patient becomes drowsy, and finally falls into complete stupor.

Apoplexy may thus be gradually produced or it may arise suddenly, the person falling down powerless and unconscious. When the full apoplectic condition is developed, whether after warning symptoms, like those mentioned above, or suddenly, the person lies totally or partially unconscious, with flaccid muscles, face probably flushed, noisy breathing, pupils of eyes large, and pulse generally full and strong and slower than natural. The motions are often passed involuntarily and urine retained. Sometimes the apoplexy comes on suddenly with paralysis on one side, and then passes on to unconsciousness—coma. In such a case probably blood has passed out of the vessels into the substance of the brain owing to the bursting of a vessel. This is **cerebral hæmorrhage.**

Treatment.—Wherever symptoms like those described under CONGESTION are present the person should guard against excitement, heavy meals, and drinking habits. He should wear loose clothing, and live in a well-ventilated, cool room. He should take moderate daily exercise, and sleep on a mattress with his head high. For medicine he should take some active purgative such as salts, seidlitz, and specially one to act on the liver like podophyllin (½-grain doses). These might be taken occasionally, and always when headache threatens. The daily morning use of a mineral water like Hunyadi Janos would be beneficial. When a person has been seized with an apoplectic fit he should be placed on a firm bed, with head high, in a cool room; his clothing should be loosed, and cold applied to his head either by cold-water cloths, or by ice pounded and put in a bladder on the head. An injection of castor-oil and turpentine, or of salt and water (see ENEMA), should be given. Whether bleeding would be beneficial or not depends on circumstances, and should be determined only by a doctor. If the pulse is feeble and the skin cold and clammy, it would be most hurtful. If recovery takes place give light diet, milk, fish, &c., and let the bowels be kept open.

Anæmia of Brain, or deficient quantity of blood, is the opposite condition to congestion. It may depend on general anæmia (see under DISEASES OF THE BLOOD, p. 313) due to loss of blood or other causes, or may come on suddenly owing to arrest of the heart's action or to bursting of some vessels in the brain.

The **symptoms** vary considerably. Generally they are not unlike those of congestion—headache, constipation, noises in the head, and so on. Insensibility may arise and frequently convulsions. The pale skin, small thready pulse, and sighing breathing will offer a contrast to the flushed face, full pulse, and noisy breathing of apoplexy, and will help to distinguish between the two.

The **treatment** depends on the cause. If there be loss of blood, that must be stopped. Good nourishing food must be given with moderate quantities of wine. Tonic medicines, especially iron and quinine, and cod-liver oil, are necessary. At the time of attack small quantities of brandy will aid recovery.

Sunstroke is an affection attended by engorgement of the blood-vessels of the brain, in which the person who has been exposed to a high temperature is suddenly seized with unconsciousness. It is described in the part on Accidents and Emergencies.

COMA, COMPRESSION AND CONCUSSION OF THE BRAIN.

Coma is a state of stupor with loss of consciousness. According to the degree of coma the person may be roused with difficulty, and then he lapses back, or he may not be able to be roused at all. It has been mentioned as occurring in inflammation of the brain and apoplexy. It also occurs in epilepsy, but in epilepsy it is of brief duration. It occurs also in disease of the kidney where the urine is suppressed. It occurs also in poisoning from alcohol and opium. The unconsciousness due to apoplexy or injury to the brain, and that caused by drunkenness, are very difficult to distinguish between. *In the cases of persons found lying unconscious in the streets, who are roused with difficulty, the chance of apoplexy or brain injury being the cause ought always to be remembered.*

In **compression** the brain is pressed on, it may be by blood which has escaped from ruptured vessels, as in apoplexy, or by a piece of bone, as in fracture of the skull, or by some body such as a bullet, which may by violence have gained entrance to the brain, or by other agents. The condition produced is similar to the comatose state due to apoplexy with bleeding, and the treatment adopted is the same. (See p. 157.)

In **concussion** or **shock** the brain is shaken, as may occur in a railway accident, for instance, where no apparent injury is done. The shock caused by a high jump, or a fall, or a blow, may produce concussion.

Symptoms.—The person becomes suddenly unconscious after the shock and lies motionless. He may be roused to give some short answer to a question, and then he lapses back. In a short time he begins to come round, moves his limbs, perhaps becomes sick and vomits, and then becomes sensible. For a time he remains giddy, confused, and sleepy. In more severe forms the stupor is more profound, the skin is pale and cold, the pupils of the eyes wide, the pulse quick and feeble, and the breathing perhaps scarcely perceptible. After recovery has taken place there is danger of inflammation of the brain.

Treatment is directed first to recovery, and second, to prevent subsequent inflammation, or excessive reaction as it is called. To aid recovery, place the patient in bed, *with the head on a level with the chest, not high.* Let warmth be restored by warm clothing, by rubbing the limbs, and, if necessary, by warm applications to the feet. *Stimulants should not be given.* Stimulants are allowable only when no attempt to rally occurs for a considerable time, and the person is still lying with cold, clammy skin and feeble pulse and unable to be roused. When the immediate shock is recovered from, the person should be kept quiet, in a dimly-lighted room, and should receive light diet and opening medicine. These precautions should continue till danger is past. If excitement threatens, let a strong purgative be given, and let iced cloths be applied to the head. The person should be watched for several weeks after a severe shock.

ABSCESS AND TUMOUR OF THE BRAIN.

When the first edition of this book was published, abscess and tumour of the brain were barely mentioned, because the detection of them during life was a matter of very great difficulty, and their treatment was an impossibility. But, in the interval since then, so great have been the strides made in medicine and surgery that in a large number of cases not only the presence of an abscess or tumour can be settled with certainty, during the patient's life, but very often its exact location can be stated, and, if undertaken in time, an operation can be done in the majority of cases, and with a large measure of success.

It is of the utmost importance, therefore, that the most skilled opinion available should be obtained in any case of head symptoms, and that no time should be put off. Many lives are lost that could be saved, were the surgeon permitted to operate while the patient still retained some measure of strength and vigour. The word "tumour" includes "abscess". An abscess, that is to say, is only a variety of tumour; but it is of so special a kind of tumour as to merit a paragraph to itself.

Abscess is a tumour consisting of a sac containing purulent fluid, that is, pus or matter. There are other kinds of tumour consisting of a sac containing fluid, blood, for instance, or a clear watery fluid, and these are called **cysts**; and there is a great variety of tumours which consist of solid material, tubercular, for instance, or cancerous, fatty or bony. But the feature of an abscess is that its contents are "matter" or pus. Now, in accordance with modern views of suppuration, the process by which matter is produced, wherever it occurs, it is due to the operation of living organisms, such as have been described in Section XXIV. An abscess in the brain, therefore, is always the result of the activity of the pus-producing organism. In a few cases the organism may reach the brain in the blood stream. This has been known to occur in typhoid fever. But in the great majority of cases the organism gains admission by a wound, as in fracture, or, and this is the most common way, from the ear, or nose, or orbit. The suppurative process is then set up and the abscess slowly or rapidly forms. There are, therefore, certain situations in the brain where abscess is commoner than in others, situations related to the place from which the organism enters. In the case of the ear, only a thin plate of bone separates the middle ear from that part of the brain lying over it, the region to which T points in the upper part of Plate XI, and this is one of the commonest seats of abscess, the infection reaching the brain from the middle ear. Another common seat is a little farther back in the region to which, on the same plate, L P points.

Symptoms in such cases need not be minutely discussed. They are headache, some change in the mental state of the patient, irritability, dulness, stupidity, an irregular temperature, a very slow pulse. Tapping the head with the point of the finger may elicit tenderness over the place where the abscess is. But besides these there are usually certain special symptoms which may not be obvious to anyone who does not carefully look for them. Thus there may be weakness or paralysis of some muscles of the face; the eye on the affected side may be wholly or partially blind, the pupils of the eyes may be unequal in size, that on the affected side being usually widely dilated. There may, later, be a staggering gait, and finally stupor comes on. The fact of cardinal importance in a case of such symptoms is that the patient has had for years a suppurating ear.

Treatment.—Surgical procedure to open the brain and get at the matter is demanded in these cases, and the sooner the grave nature of the case is realized, and the operation done, the better. Nothing else is of the slightest use. If a surgeon is not available to do this, all that can be done is to make sure of the condition of the head as to wounds or injuries, the state of the ears, nose, &c., and, where any suspicion regarding the ear exists, to bathe or syringe with antiseptic solutions.

Tumour of the Brain.—Tubercular tumours of the brain are the commonest and syphilitic tumours, but any kind, cancerous among them, may be present. While abscess of the brain has, because of reasons already stated, certain favourite seats, tumour may be present anywhere, and, in the case of tubercle and syphilis, many of varying size may be scattered about. It has been abundantly proved that a tumour or tumours may exist, and give no sign of their presence. But reference to what has been said about certain areas of brain being devoted to certain purposes, and to the figures illustrating this (p. 147), and also reference to Plate XI., will immediately suggest to anyone that if a tumour lay upon, or pressed upon or destroyed any of these areas, the affected area would no longer be able to perform its business, and thus special symptoms would be produced, according to the exact area or areas involved.

Symptoms of tumour are thus of two kinds: (1) general symptoms, such as headache, giddiness, vomiting, blindness, changes in the pulse, changes in the patient's mental condition, not materially differing from those of abscess of the brain; and (2) special symptoms, dependent upon the situation of the tumour.

It is the special symptoms which enable one, when they are marked, to form an opinion as to the exact seat of the tumour. For instance, if a small tumour pressed upon the area of the brain shown in Fig. 97 to be concerned with the movements of the fingers of the left hand, if the pressure were only sufficient to irritate this area, then there would be spasms of the fingers, jerking movements of one kind or other. If, on the other hand, the growth pressed sufficiently to destroy the area, then the fingers would be paralysed. Sometimes the irritation due to a tumour produces convulsions, but if the tumour were situated as supposed, careful observation would show that the convulsion began always in the fingers of the left hand, and from them spread over the body. Thus the special symptoms might include a spasm limited to one muscle or a group of muscles, or a general convulsion always beginning in the same way, or it might be the paralysis of a muscle or group of muscles, or the whole or part of a limb. It might be a spasm of pain or tingling always in one place, or loss of feeling in a limited part of the body; it might be blindness or partial blindness of one or both eyes, affections of speech, and so on. Such symptoms, when carefully observed and noted, enable the physician or surgeon to come to a conclusion as to the locality of the tumour, and are, therefore, called localizing symptoms.

Treatment.—A surgeon would always operate on an abscess of the brain, because, if it could be reached at all, the mere passing into it of a probe or a fine knife would permit the escape of the pus; but, in the case of a solid tumour, a surgeon would only undertake an operation if he had some idea that it was possible to get at it sufficiently well to cut it out, and if he had some idea of its nature. Doubtless a surgeon would, for instance, consider himself justified in operating if the special symptoms pointed to a tumour just on the surface of the brain, but not if they pointed to one at the base, where it would practically be out of reach.

DELIRIUM TREMENS AND DIPSOMANIA.

Delirium Tremens.—Delirium is a symptom in many diseases; but delirium tremens arises directly from poisoning by alcoholic drinks. It very often occurs, not during the drinking-bout, but after it, sometimes many days after the person has begun entirely to abstain.

The **symptoms** begin with loss of appetite, sickness, constipation of the bowels, and sleeplessness or irregular sleep, disturbed with frightful dreams. Then the tendency to delirium begins to appear in restlessness, suspicion, and tendency to quarrel; the patient is under great dread of something, and extreme tremulousness of his muscles is present. When the delirium is established he is still full of fear and suspicion, searching under the bed and behind curtains for concealed persons; he is talkative and incoherent, but can readily recover himself and talk for a little sensibly, soon yielding again to the delirium. He has hallucinations of sight, smell, and hearing, tries to grasp at things he sees floating or lying before him, or to strike at the insects, animals, or imps that swarm on and round him, mocking and leering at him. The delirium may become maniacal, and he may attack his attendants in his excitement. He may have had no rest for nights, and may have been without food for days. There is generally thirst, but no appetite.

Favourable cases tend to yield of themselves in three or four days, convalescence beginning by a good sleep of many hours. But instead of this favourable result the delirium may go on, and the person become weak, the temperature rise, and convulsions, going on to coma, may end in death.

Treatment.—Place the patient where he can be kept quiet, in a darkened room, free from noise or excitement, and carefully watched. The patient in delirium tremens is sometimes so outrageous and dangerous as to require to be tied down in bed or restrained in other ways; hence the need of watching. He should have small quantities of nourishing food often, milk, beef-tea, eggs, &c. His bowels should be regulated by saline medicines. Sleep should be procured, and for that purpose 15 grains hydrate of chloral may be given in one dose, to be followed by another dose of 15 grains within an hour, but *only if the first has failed to give sleep.* Without medical advice no further dose should be given till four or six hours later, when, *if necessary*, other 15 grains may be given. But it must be remembered that *chloral requires caution in its use*, so many accidents have arisen in its administration. If chloral cannot be got laudanum may be given; 20 drops for the first dose, a second dose of half the strength in an hour if required, and further doses of 10 drops every two hours, if necessary, for six or eight hours. The patient should be strictly kept from all stimulants. After sleep has been obtained and recovery is begun give quinine and iron tonics.

Dipsomania is a condition to which drunkards are liable, in which there is intense craving for drink, not easy for the victims to resist. It comes on in paroxysms, which may last for days or even weeks, and the paroxysms may recur at long intervals.

Treatment.—The sufferer is not to be regarded merely as a victim to cravings which he cannot resist, and for which he is, therefore, unaccountable. They can be resisted, and are, besides, the direct consequences of his own habits. He should, therefore, be put into conditions as favourable as possible for his aid. He should have good and nourishing but light diet, no highly-seasoned dishes. His bowels should be carefully regulated with saline medicines. Change of air and change of society will do much for him; and this will be aided by an active occupation. Some effort should be taken to keep temptation out of his way. Some medicines are recommended as a substitute for his accustomed stimulant. The following has often proved useful:—

Tincture of Gentian, Tincture of Ginger,	of each 1 ounce.
Tincture of Cayenne,	¼ of an ounce.
Syrup flavoured with Tincture of Orange,	1 ounce.
Water,	1 ounce. Mix.

Give a tea-spoonful in half a wine-glassful of water when required. Tincture of the red cinchona bark has been much lauded in America for such cases. It is ordered in tea-spoonful doses, and to each dose 6 drops of tincture of nux vomica may be added.

In the writer's experience there are only three methods which give any promise of success in the treatment of chronic inebriety. The first consists in placing the person in charge of someone who will exercise a constant supervision. This is a method that is very irksome to the patient and very expensive. The second consists in consigning the patient for a time—six, twelve, eighteen months, or longer—to an institution, public or private, where the patient is kept, and where drink is not to be had. If the patient is long enough in residence, the long-continued abstinence from alcohol permits the re-establishment of nerve tone and nerve control. But not many people can afford thus to go away from home and business for a year or more. The third method is the adoption of one or other of the "Drink cures," of which the "Keeley cure" is the type. The essence of this consists in the injection, under the skin, thrice daily, of a drug whose nature is not stated, and the administration of a tonic by the mouth six times a day. The usual length of treatment is three weeks. This treatment may be carried out without the patient's business arrangements, &c., being upset; all that is necessary is that he present himself at the stated hours daily for the injections. In connection, however, with the "cure" there are usually private institutions where the patient may live while the treatment is being carried out. Thus in London there is a home in connection with the Keeley treatment, and in Liverpool there is one connected with the "Leyfield-Hayden" treatment, and there are others also.

Inebriate Homes where sufferers from chronic inebriety are taken for residence merely, and supervision, are numerous, and their cost varies. There are a few also for the working-classes. As already noted, however, residence must be prolonged to be of any value. On the whole they are not, in the author's opinion, satisfactory. On the other hand, although the Keeley and other "cures" are undoubted "quack methods," the author is bound to say that he has seen more benefit from them than from any other method whatever. If the patient really desires help to give up his habits of drinking, and is willing, once he is cured of his drink crave, never to taste alcoholic liquors again, he should be recommended to place himself under the supervision, for the needful three weeks, of the Keeley authorities, or the other already named. The success of the Keeley method has led to various imitations. The "Leyfield-Hayden" method the author has found quite satisfactory, but there are others also, of which he has no knowledge, but which may be just as useful. In any case a patient should not be sent to any institution till someone or other, acting on his behalf, has made full enquiries, and has actually visited the establishment where the treatment is carried on.

INSANITY.

It is not proposed here to give any detailed account of the nature, causes, symptoms, &c., of insanity or madness. The subject is one of great difficulty, engrossing all the powers and abilities of medical men of eminence who have devoted themselves specially to its study and treatment. It cannot, therefore, be expected that anything but a very general sketch of it can be given in such a work as this, intended for the reading of the general public. What will be attempted here will be to put down, as simply as possible, practical points connected with the causes and signs of insanity, and the general treatment of the insane, which the public ought to make themselves acquainted with. The knowledge of these points may help some to regulate their own or the lives of others in a way to ward off an infliction that may be suspected and dreaded, and may also lead to more proper views of a distressing malady about which, even yet, there are utterly erroneous views and prejudices.

For a long time the insane were regarded as people deserving of being cast outside of the pale of civilization. They were viewed as people who had been singled out by God for the purpose of being branded with marks of his special abhorrence, or as people given over to the power and kingdom of the devil. Society, therefore, could only cast them out from its midst, and humanity could have no feeling for their distresses. No wonder then that they became the victims of horrid cruelty or barbarous neglect. A hundred years have not yet elapsed since Pinel released in Paris fifty insane who had been for years chained in dungeons. Now, however, general enlightenment, and specially the progress of medicine, have brought about a better state of feeling. It is now recognized that an insane or perverted state of mind is accompanied by and due to an unsound and perverted state of body. A man who suffers from breathlessness, pain, and weakness, owing to an unsound state of lungs, is pitied and cared for. It is admitted that the symptoms from which he suffers are due to a disease in his lungs, the presence of which commends him to our consideration and kindness. The brain is as much a bodily organ as the lungs; feeling, will, intelligence, are as much the functions or duties of the brain, however much more they may be, as are all the functions involved in respiration the duties of the lungs. Interference with these functions of respiration, diseases preventing their performance or altering and perverting their characters, are regarded as diseases of the lung, and so interference with the intellectual faculties, altered or perverted will or feelings, are to be regarded as diseases of the brain. The man who suffers from lung disease is not regarded as a criminal or degraded, neither should the man who suffers from diseased brain. Both are unfortunate sufferers to be dealt with patiently, and sympathetically, and skilfully, the insane not less but rather more than the consumptive. In all cases of insanity alterations of one kind or another may be found in the tissues of the brain, and these medical science regards as the causes of the disease.

Insanity, then, is a disease of the brain, having for its symptoms enfeeblement, excitement, or derangement of the mental faculties. This departure from the normal state of mind is shown in the speech and conduct, and often in accompanying disturbances of other bodily organs.

It is to be noted that temporary derangement may be present, as excitement or delirium, in fever, or due to the action of poisons like opium, belladonna, henbane, Indian hemp, or alcohol, which are not included under the term insanity.

Also it must be observed that insanity is to be regarded as a *departure from the normal in the individual himself*. One man may have unusual ideas and actions, or his conduct may be unusual from that of his fellowmen, but that need not be insanity. We call him peculiar or eccentric. It is when a man, whose conduct and mode of life up to a particular period have been of the ordinary kind, suddenly or slowly becomes changed in character and disposition (not, it is to be noticed, suiting himself to new circumstances or new views) that his sanity may be questioned. When the cheerful man becomes morose, sullen, desponding, when the kind and gentle becomes harsh and brutal, when the virtuous becomes obscene, and the peaceful becomes violent and turbulent, it is then that there is the departure from the normal of the insane kind.

Now while insanity is a disease of the brain, nay just because it is a disease of the brain, it has causes that may be to some extent understood, and to a large extent guarded against. Even as, to return to our former illustration, a man may have brought on the disease in his lungs we call consumption by his own neglect or folly, so may another by his own acts lay himself open to insanity. The man who, with no great disease-resisting power, catches cold by going about in damp clothes, and then adopts no measures to drive off the attack, but permits it to take firmer and firmer grip of him, is actually responsible should consumption in course of time develop itself. Similarly an individual with a weak or excitable nervous system who indulges in excesses of passion or vice, even in passions that are not in themselves immoral, may become actually responsible for an attack of insanity.

We shall now proceed to discuss briefly in detail the various causes of insanity.

PREDISPOSING CAUSES OF INSANITY.

Heredity.—The effects on disease in general of the influence of parents have been already discussed at some length at page 30 and the two following pages. Much of what is written there is directly applicable to the special disease now being discussed, and reference should be made to these pages. Insanity in the parents is one of the most frequent causes of insanity in the offspring. Dr. Maudsley says that at least one-fourth of all the people who so suffer have inherited the disease; and it is said to be more frequently inherited from the mother than from the father, and by the daughters than by the sons. Further, it is not uncommon for insanity in the children to be due to other nervous diseases in the parents. Epilepsy, for instance, in the father may produce insanity in the child. As already observed (p. 31), drunkenness in the parents may be a predisposing cause of madness in the children, probably because constant alcoholic excess seriously deteriorates the brain tissue generally. Frequent intermarriage of close relations, it is well known, has a bad effect upon the offspring. Breeders of animals know full well that they must introduce fresh blood every now and again to maintain the quality of their stock. The same is equally true of the human species. The brain shares in the general bad influence of frequent intermarriage, which thus tends to produce a liability to insanity. The popular prejudice against marriage between full cousins is not without ground.

Education is second in importance only to heredity, if indeed second to it, in the consideration of mental disease.

First of all, a mind that is not naturally strong may be marvellously improved by judicious training. It is a physiological rule applicable to the whole body that regular exercise, followed by equally and regular stated periods of repose, promotes the activity and health of the tissues, and, if regular and not excessive, increases their strength and efficiency. It is the regular and yet not excessive exercise that the blacksmith's arm receives that produces such brawny well-developed muscles. It is a second rule, equally applicable to all the tissues, that want of use is shortly accompanied by degeneration, and perhaps finally complete decay. The arm that is kept tied up for weeks without exercise because of fracture, when taken down has lost much flesh, is thin, and weak. Finally, youth is the time when such regular exercise is capable of stimulating to greatest strength and development. Now all these rules applied to brain mean that a faculty, whether it be of observation or of memory, of self-restraint or of will, of imagination or of reason, which receives this early, regular, and careful exercise, is stimulated to growth, and increased in strength. Hence, careful training may do much to ward off degeneration from a naturally weak nervous organization. The reverse is equally true, that want of training may not only leave the weak brain an easy prey to disease, but may actually cause it to grow weaker, and so become a more easy victim.

Secondly, the kind of training may directly excite the disease to the attack. Repression, harshness, and cruelty, excessive mental exercise, compelling children to cram too many lessons, or, on the other hand, want of control over children, yielding to their every desire, and letting them yield to their angry fits or tempers, all these are injurious. Deep impressions made on children's minds, by terrifying stories or sudden frights, will have similar bad effects.

Sex does not seem to have any important influence on the disease.

Age.—In regard to this it is only necessary to remark that, while no age is exempt, insanity is commonest between the ages of twenty-five and fifty, probably because it is between these years that labours, worries, and anxieties are greatest in number and intensity.

Social Condition.—It seems that the married relationship tends to preserve health and sanity. Among the insane there are more single than married people.

EXCITING CAUSES OF INSANITY.

These are generally classified as **moral** and **physical**.

Moral causes of insanity are such as vexation, grief, or anxiety. Emotions, and depressing emotions specially, are causes. Jealousy, unrequited love, distress at loss of fortune or friends, or failure in the objects of ambition, the anxiety caused by heavy responsibilities, religious excitement, or depression, and such as these, are the exciting causes of the change. Intellectual labour, pure and simple, and joyful emotions, rarely produce it.

Physical causes include those that act upon the general system, such as injuries or diseases. Various diseases of the brain and spinal cord, and even diseases of lungs, liver, kidneys, and other organs, gout, epilepsy, and so on, are capable of producing the affection. Exciting causes of great importance are found in women in connection with menstruation and the period of its cessation, and with pregnancy and delivery. Excesses in drink, in drugs like opium, as well as sexual excesses, are among the commonest of exciting causes.

GENERAL SYMPTOMS OF INSANITY.

Probably the first thing noticed about a person whose mind is becoming affected is some change in the state of feeling, some depression or elevation. Under this change the person becomes restless, morose, sad, mirthless, indifferent, irritable, or reckless and extravagantly joyous and merry. Under the operation of the disease the person's moral nature may become perverted, so that he is untruthful and dishonest, vicious or immoral. The moral perversion may be so great as to lead to yielding to some wild impulse or fury that ends in violent or murderous acts. It must be again noted that the former character of the patient is the standard by which his present, supposed insane, conduct is to be judged.

Further, some faculty of mind becomes impaired, memory often and reason, though frequently the quite insane person will argue with apparent smartness and ready wit. The intellectual disorder may show itself in slowness of thought and incoherence of speech. Will also becomes perverted, so that the person is weak and fickle, or stubborn and perverse. Thus some insane patients have the delusion that they are acting under the will of some other whose commands, no matter what they be, they are bound to obey, so that they are impelled by impulses whose time and direction cannot be reckoned on.

A common symptom of insanity is the existence of illusions and hallucinations. The term "**illusions**" is applied when the patient sees some object actually before his eyes, but, under the influence of his diseased brain, the object becomes transformed to him into something quite different from what it actually is. Thus shadows are taken for fiends or wild beasts, dust becomes grains of gold, pebbles become diamonds. In the same way all his senses may cheat him; a noise may be a voice speaking to him, the wind may whisper evil things to him, and so on. But when a person sees something when there is nothing to correspond to it externally, when he hears a voice and there is no sound even to explain his imagination, that is, when there is nothing affecting the senses from without to give occasion for the diseased imagination, the person is said to be the victim of a **hallucination**. Often these hallucinations govern the person's life to a great extent. He sees figures beckoning him onwards, and he must follow; friends long dead throng round him; voices command him, and he must obey though they incite to murder. Thus tendencies to suicide and murder are often due to such hallucinations. **Delusions**, again, are false ideas originated by the disease in the person's mind, such as that his head is made of glass, that he is heir to the throne, &c. Besides these disturbances of feeling, intelligence, will, and sense, there are such affections as paralysis, epilepsy, catalepsy, convulsions, and others, to which the insane are liable.

KINDS OF INSANITY.

Six general types of insanity are described, namely, **Melancholia, Mania, Monomania, Dementia, Idiocy,** and **General Paralysis of the Insane.** It is not meant that these are different forms of insanity absolutely marked off from one another, for all the forms merge into one another. According to the main features of the disease, as exhibited in a particular person, is it put into one or other of these classes. These main features or general characters will now be briefly described. Very many cases of all kinds begin by manifestations of altered feelings, generally feelings of a depressed and sorrowful character. The symptoms that lead to the person being classed as melancholic or maniacal, &c., develop afterwards.

Melancholia, or **Morbid Depression.**—In this form the depression of spirits is great, and may lead to the person withdrawing from society, and even from his dearest friends. All things and persons become repugnant to him. He is irritable, morose, and suspicious. He is often the victim of delusions or hallucinations—people are watching him, whispering about him, plotting against him; the world is ruined and he is doomed; or he is bewitched, possessed, magnetized. Such are the delusions which affect him. Sometimes the person imagines part of his body is made of glass, or has similar absurd notions.

As a result of all this misery the tendency to suicide is almost inevitable.

Melancholia may lead to attacks of mania, or of excitement bordering on it. Half of such cases recover in the end, though a relapse is to be feared. Recovery, which is usually gradual, is to be looked for within six or twelve months, and need not be expected after that time.

Hypochondriasis is a form of melancholia in which the person believes himself to be suffering from serious illness. He is troubled with all sorts of complaints, which he is constantly discussing, watching, and seeking treatment for.

Mania, or **Morbid Excitement,** may break out suddenly, but usually follows a period of depression like that of melancholia. At length, and perhaps by slow stages, the depression yields to excitement, displayed by quickness and loudness of speech, readiness to laughter or anger, and incessant bodily activity. The activity may find vent in shouting, leaping, &c., may show itself by a sort of intellectual elevation, sparkling or witty speech and conversation, humorous sallies, or may be of a degraded sort, displaying itself by cursing, swearing, violence and assault, or acts of shame and wantonness. Sleep is often diminished, and the state of restless activity may continue for days and nights without apparent fatigue of the patient. Delusions and hallucinations are present here also, but they have not the settled hold characteristic of melancholia.

Maniacal attacks are apt to be periodic, the return of the mania being in women determined frequently by the menstrual period. Mania is often alternated with melancholia.

Recovery is generally slow, though it may be sudden, and occurs most frequently within a year. After the end of the second year the case is nearly hopeless. If recovery do not take place the mania may become chronic, or may pass into dementia, unless death is caused by other disease, or by violence at the person's own hands.

Monomania is the form of insanity in which the person is possessed by some fixed idea. Frequently, apart from the particular idea, the person seems perfectly sane and intelligent, and no mental disorder is noted until the particular idea comes up. Sometimes, also, monomaniacs seem to avoid the delusion which affects them. The delusion may be of any kind. The person may imagine himself to be some emperor, statesman, orator, or poet. Under the influence of the dominating idea the person puts on airs suited to the character he is supposed to be, haughty and arrogant, or affable and condescending. The delusion may be of a low form, and is manifested by moods suited to it. The person may imagine he is peculiarly constructed, and certain precautions must be taken with him. Thus he may suppose his head to be made of glass, &c. Monomania has less chance of cure than mania.

Paranoia is a form of insanity characterized by an elaborate system of fixed delusions.

Dementia is characterized by feebleness of mind. It is, in fact, enfeeblement of mind. It is the result of incurable melancholy or mania, and follows diseases like softening of the brain and long indulgence in drink. It may be merely an accompaniment of old age. In dementia there is not only intellectual but moral feebleness. The person is not only silly, weak, childish, but has no depth of feeling, is indifferent, and cares for nothing. Memory is also impaired. While, however, the things of yesterday are entirely forgotten, the events of early life may throng up and the person live in the past, as it were, calling the persons round him by the names of those he knew in youth, who have been long dead or absent. Demented persons often busy themselves with curious occupations. They usually live for many years, and enjoy good health, appetite, and sleep.

Dementia Præcox is a form of mental weakness occurring in early life—an insanity of adolescence.

Idiocy is a condition of absence of intellect which dates from birth. It is often a consequence of too close intermarriage, or of drunkenness on the part of the parents. It may be occasioned during infancy by epilepsy, or by injuries to the brain, or by some severe strain or fright.

Idiots have a vacant expression of countenance, small and misshapen head, awkward walk, and are liable to sudden changes of temper and outbreaks of spiteful anger. Speech is, as a rule, imperfect, and in one class of idiots is entirely absent. Idiocy is frequently accompanied by dulness of hearing.

Idiots are incurable, but capable of great improvement by careful training.

General Paralysis of the Insane has many symptoms similar to those described under the various other forms of insanity, but has besides, as a special feature, paralysis which slowly extends till it affects all the voluntary muscles. Slowly creeping paralysis may be the first symptom of the disease, paralysis which begins with loss of muscular power. The patient begins to speak indistinctly; his lips and tongue tremble when he speaks, so that his utterance is tremulous; his hands tremble when he tries to use them, his legs when he tries to walk, so that he totters and stumbles. It may not be till these symptoms have considerably advanced that signs of insanity appear, signs of mental excitement, of delirium, of delusions, or it may be signs similar to those described under melancholia. It may be that the disease begins with melancholy excitement or fits, and that the paralysis does not appear till later. However it be, in the end the person's mind becomes so enfeebled that intelligence and memory have almost disappeared, and he sinks into the condition of dementia, while the paralysis may be so extreme that he cannot walk, dress or undress, or feed himself, without aid, and may even have difficulty in swallowing, has no control over his bowels or bladder, and loses power also of feeling.

This disease is practically incurable.

Death usually occurs within three years of the commencement of the disease, death from apoplectic convulsions, or from suffocation from the defect of swallowing allowing food to get into the windpipe, or from exhaustion.

Other forms of insanity exist, such as **puerperal insanity**, that is, the insanity attending pregnancy, childbirth, and nursing, and insanity attending menstruation, which are described under DISEASES OF WOMEN.

The insanity of **delirium tremens** has already been described (p. 160).

Besides, there is a form of insanity due to self-abuse, accompanied by weak-mindedness, indecision, delusions, and hypochondriasis.

General Treatment of Insanity.—It has been remarked that idiocy, dementia, and general paralysis of the insane are practically incurable, so that treatment consists only of care and supervision of the unfortunate sufferers. This implies careful selection of appropriate food, regulation of the bowels, regulation also of hours devoted to sleep, to exercise, so far as the patient can engage in it, to work maybe, or recreation. It has been already said that idiots are capable of great improvement by judicious and constant training. Besides this kind of supervision there is also in such cases a large amount of restraint necessary, moral restraint to control fits of anger, spite, or excess in various other directions, and physical to prevent outbursts of violence that might be dangerous to the patient or others. The best place for such treatment is undoubtedly an asylum. Of course there are many cases of idiots who, if the circumstances of the friends permitted it, might be as well treated at home.

As to other forms of insanity, the question of treatment in a private home or in an asylum depends on the nature of the case and chance of recovery. When the mental disturbance has been caused by pressure of troubles or by excesses in drink, or immorality, and where lapse of time has not confirmed the disease, the best treatment consists in total change of circumstances. The business man must be freed from his business worries, the literary man from his books; or, if the insanity has been caused by loss of friends, disappointments, or failures, only change of circumstances, with abundant external attractions in the shape of new acquaintances, new occupations, new surroundings, is capable of diverting the mind from its morbid dwelling upon itself, and of driving from the memory old and sad associations. This may be effected, if the patient's means can afford it, by intrusting the person to some skilled attendant, under whose charge he may be permitted to travel, or by sending the person to some private home at the seaside or in the country kept by a properly qualified medical man.

Some cases manifestly must go to an asylum, such as cases of mania, cases where suicide is possible, or where violent outbursts might lead to murderous attacks, cases, in short, of mania, monomania, and melancholia of pronounced character.

It may be observed that cases of insanity affecting women, often young women, and associated with sexual functions, cases with a strong element of hysteria, can never be properly treated by the patient's friends. They require firm control, while the patient's friends invariably find themselves unable to resist the thousand-and-one whims and caprices which are so perplexing an element in such cases. Frequently such cases, curable at first by proper control, become hopeless from the difficulty of proper management in the patient's own home, owing to the leniency and affectionate but *unwise* solicitude of friends.

The medicinal treatment of insanity, if any were adopted, would be determined by the view taken, in the particular case, as to the causes of the mental condition. General conditions of ill-health, diseased conditions of stomach, liver, kidneys, and in women affections of the generative organs, ought to receive appropriate treatment. Indeed the very first thing to be done, in the case of any person showing signs of mental alienation, would be to have the person carefully and systematically examined by a physician in order that any contributing cause, connected with other organs than the brain, might be discovered and removed, if possible. But it should be noted that in cases of morbid depression remarkable results have been obtained by treatment with thyroid extract, and also by the galvanic, and the high-frequency, electric current (see Vol. II. p. 468).

THE PREVENTION OF INSANITY.

Prevention is, for the public, a much more important question than treatment. Parents, guardians, and individuals can wield here a great influence, if they only know how.

First of all, all parents and guardians should so nourish, train, and educate children of whom they have the care, so as to develop to the utmost their strength of body and soundness of mind.

Secondly, parents and guardians should take special precautions in the rearing of children any of whose relatives in a direct line have shown tendencies to, or have been actually affected by, insanity.

Thirdly, individuals who are of an age to regulate their own lives ought to beware of excesses likely to lead to nervous exhaustion or degeneration, and, where a bad tendency exists in the family, ought to, if possible, so frame their lives as regards business, amusements, and other pursuits as to secure a calm and equable frame of mind, free from sudden strains or strong excitements.

As regards the duties of parents and guardians, it is to be feared that the extent to which oversight is demanded is not properly realized. It involves attention to diet, to clothing, to exercise; it should have strict regard to the due proportion of work and play, study and amusement, and not that only, but also the kind of work and play, the species of study, and sort of amusement. Among the better classes the tendency is to leave a good deal at home in the hands of upper servants and nurses, and to leave the education of the child entirely in the hands of the masters at school. The result is, that at school the child is carried on with the rest in its class, it being impossible for a master at school to deal with individual peculiarities in a large class, and at home the child is at the mercy of servants, a large number of whom certainly are actuated by good motives, and exercise their power to the advantage of the child, but some of whom may obtain obedience by threats and rule by fear. Many children owe a nervous disposition and unstable mind to terrors produced by tales told by its nurse, or by being left in a dark nursery for hours alone, and in other similar ways. For like reasons the influence of companions must be watched. Among the poorer classes it is not an uncommon spectacle to see the eldest of a large family of little ones, herself quite young, being compelled, in order to help her mother (!), to assume herself the cares of a mother, and to be responsible for the other children. In these days education worries are not limited to the children of the rich. In Great Britain the operation of the School Boards is limited to no class, and under the code system a scientific species of cram is taking the place of education. Large classes of children are taught together—taught in bulk—all to come up to one standard, as if they were all made in one mould. Under this system the weak must suffer. Parents, therefore, must not think that state regulation of education relieves them of responsibility. It only increases the responsibility. The responsibility of the state is for the mass, the responsibility of the parent is for the individual child. It becomes, therefore, the urgent duty of parents to watch their children, and if the fear of undue pressure at school arise, to seek the opinion of a physician, and if so advised to get the child relieved from some of its burden of lessons. Another thing to which parents ought to give their attention is the school hours. It is not an infrequent thing for children to be engaged at school from 9 a.m. to 3 or 4 p.m., with no sufficiently long interval in which to go home and get dinner without undue haste. In these circumstances it would be best, if care be taken that the child has a good breakfast, that the child should get a light lunch, in summer of milk with bread and butter or preserves, and in winter of soup or broth and toast, and that dinner should be postponed till after school. But in such an arrangement care must be taken that the child is up and dressed early enough to permit of breakfast being leisurely taken.

Special care must be given to children in whom there is a probability of hereditary disease. In particular, they ought to be kept under a wise control, and trained to a proper self-control, so that angry fits and passions are subdued and held in check. With them education may be all-powerful, if badly directed, to hasten the development of the disease, if prudently conducted to strengthen and develop what may be naturally weak.

Individuals who guide their own lives, and have in view the fact that madness has been in their family, and that therefore for them it may be a prospect, or who, for other reasons, fear its advent, should face the risk. If they do so boldly, they will choose occupations and engage in amusements that are unexciting in character; they will avoid excess of all kinds, and especially avoid indulgence in strong drinks and animal passions, and will find means for quiet but profitable occupation in leisure hours.

PROMINENT NERVOUS SYMPTOMS

HEADACHE AND GIDDINESS.

Headache (*Cephalalgia*) is extremely common, and is of so many different kinds and arising from so many different causes that one treatment for all is impossible.

It may be a symptom of a disease, rather than a disease in itself. For example, it is one of the commonest and most painful symptoms in *disease of the brain* and its membranes; headache, giddiness and vomiting are early symptoms in affection of the brain owing to *disease of the ear* (see p. 154), and it is usual in fevers and other acute diseases. Further, it is a result of improper conditions of the blood—*poverty of blood*, or when the blood is impure owing to *rheumatic or gouty affections*, or owing to *disease of the kidneys.* In fact, headache may be a mere accident, or rather accompaniment, of other diseases, which must be attacked before the headache will be relieved. One of these diseases—*Syphilis*—deserves special attention. The headache due to syphilis, contracted perhaps years before, is of a most painful and persistent character. It has often lasted for weeks and brought the patient to the verge of suicide. The treatment for it is undoubtedly large doses of Iodide of Potassium, but the drug must be given with certain precautions, for which see under SYPHILIS.

In *disorders of digestion*, and specially connected with the liver, headache is generally so prominent a symptom as to be counted almost the real trouble, and hence is called **bilious headache**. It is usually of an intense character, throbbing or bursting and soon accompanied by sickness. If vomiting occurs, the nausea is generally relieved, and the headache then yields to sleep. Often the vomiting does not occur, and hence the popular resort to a glass of warm water with a large tea-spoonful of mustard stirred in it in order to induce vomiting. This treatment may be adopted, and often relieves so quickly that sleep is induced and completes the cure so far as the headache is concerned.

Constipation is another frequent trouble producing headache. To relieve it, as well as to unload the liver, a blue-pill at night, followed in the morning by a tea-spoonful of Epsom-salts in a tumbler of hot water, is very useful. People troubled with such disordered digestive organs will find the daily or at least frequent use, in the morning before breakfast, of mild opening medicine like Hunyadi Janos mineral water (a wine-glassful), Eno's Fruit Salt, or other saline purgative, of great value. Where *flatulence* is conjoined with constipation a tea-spoonful of Aromatic Spirits of Ammonia in a glass of water is often beneficial.

Decayed Teeth must not be forgotten as not infrequent producers of headache.

Disease of the womb is a common cause in women.

Arsenical poisoning is accompanied by intense headache. Other symptoms go along with it—sickness, griping pains, depression. Now one of the prettiest green colours is made with arsenic, and this colouring matter is frequently used for wall-papers. The heat produced by a fire in the room will readily cause the arsenic to come out of the wall-paper, so coloured, in invisible vapour, which the persons sitting in the room will inhale. They may, therefore, suffer from the above-mentioned symptoms. Thus some persons have been accustomed to be plagued with headaches and nausea when they rose in the mornings during the winter months, and when they went away for a short holiday, or with the advent of summer, the headaches disappeared. Careful inquiry has found the cause in their bed-room paper. They used fires in winter, which brought out the arsenic, and so the persons rose in the morning unrefreshed after inhaling arsenical vapours during the night. With the arrival of summer the fires were left off, the arsenic was not vaporized, and the symptoms disappeared. Similarly others have been afflicted with headache after sitting some hours in their drawing-room, or some particular sitting-room or study. Therefore all who are similarly troubled should examine any green papers that may be on their walls; *and no householder should permit a green paper to be put on a wall in his house, unless a chemist has certified it to be free from arsenic. Let him not trust the painter or the seller of the paper.*

Apart, however, from affections like these, in which it is mainly an indication of the real disease, headache may be almost or actually an affection in itself.

Of this sort three main types may be taken.

I. **Headache due to congestion of blood-vessels** in the brain, that is, to too much blood in the brain. This is the **congestive**

or plethoric headache. It is attended with throbbing blood-vessels, is of a heavy dull sort, often accompanied with giddiness, and liable especially to attack full-blooded people who live well and take too little exercise. In women it will tend to occur if the monthly periods be insufficient or suppressed.

II. **Headache due to too little blood in the brain** is the opposite of the above, and is called the **anæmic** headache. Pale, weak girls who suffer from excessive regular discharge, mothers exhausted by nursing, the badly fed and ill nourished, are liable to this form. Besides, these conditions may quickly arise in people in ordinary health, producing this anæmic condition of the brain, lasting for a short time, and exciting a headache. It is well known that during sleep the brain has a much smaller blood-supply than in waking hours, and it may well be that the headache that many people experience, if they sleep beyond their usual time, is due to this condition too much prolonged. The anæmic variety is accompanied by listlessness, indisposition to usual work, and so on.

III. **The nervous headache** is perhaps commoner than any. It will come on from many causes; loud noises, slight excitements, will readily provoke it in some. Teachers seem peculiarly liable to it. The studious, and those who work with their brains, so to speak, find it a frequent companion. "Thunder in the air" is often said to provoke it. Fatigue, such as ladies undergo during "shopping," late study, business worry, all these are inseparably linked to it. A form of the nervous headache is called **megrim or brow ague.** It particularly affects delicate women, in whom fatigue, confined hot rooms, or errors in diet speedily excite it. It is an aching pain, attended often by sudden shooting pains, and throbbing vessels. Beginning dull, it gradually becomes intense, becomes intolerable by movement, gives rise to an intense nausea, which may occasion vomiting, and terminates in sleep. It is, curiously enough, hereditary, and comes on, in those afflicted with it, at regular intervals. Disorders of sight and speech sometimes attend it.

Under the nervous variety may be classed the **neuralgic headache.** The slightest exposure to cold may bring it on. The pain of it is frequently of a shooting character, and it often comes on regularly at a particular time of day or night.

Treatment.—*For the congestive variety* a good purgative medicine is desirable—rhubarb and magnesia, Gregory's powder, aloes-pill, seidlitz-powder, &c., with regulation of diet—which should be plain—exercise, and fresh air.

For the anæmic variety, good food, iron tonic (see PRESCRIPTIONS), and similar means of getting up the system are obviously required.

A good meal has cured many a headache. It may be that, the person having long fasted, the blood has "gone to the head," since there is no work for it to do in the digestive organs, which in fasting are always pale. As soon as the person has taken a good meal the blood rushes down to the stomach and bowels to supply means for their activity; and so the headache is relieved. In such a case, of course, the long fast indicates the remedy.

For the nervous headache a great variety of medicines has been recommended. The really nervous form is often greatly benefited by nerve tonics, and specially by phosphorus. To teachers and studious people this may specially be recommended. The writer has known cases of teachers to whom nervous headache was a perfect plague, who could scarcely teach for two or three hours without its appearance, and to whom phosphorus in pill was a great boon. The best way to obtain it is in pill. These pills may now be obtained all over the world—either Richardson's pill or M'Kesson & Robbins (New York). The quantity of phosphorus in each pill should be $\frac{1}{50}$th to $\frac{1}{30}$th of a grain, and may be obtained alone in the pill, or combined with iron (2 grs.), nux vomica ($\frac{1}{8}$ to $\frac{1}{6}$ gr.), and quinine ($\frac{1}{2}$ to 1 gr.). The latter combination is good for people needing general strengthening. The same makers put up a pill, very useful for females, of phosphorus ($\frac{1}{50}$th gr.) and valerianate of zinc (1 gr.)

For *megrim* a good and safe remedy is bromide of potassium, 30 grs. in a wine-glassful of water. A remedy recently used and of great value is the effervescing citrate of caffein, of which one tea-spoonful may be taken in a wine-glassful of water every hour for several doses. In America guarana (Brazilian cocoa) has been much used in 15-grain doses. Chloride of ammonium (sal ammoniac), in doses of from thirty to forty grains in milk three or four times a day, is a favourite remedy with some.

As a preventive a mineral water like Hunyadi Janos every morning, or fruit salt, or even a tumbler of common salt and water, is strongly advised. The use of strong tea, coffee, or tobacco should be discontinued.

For the *neuralgic headache* nothing is more valuable than a powder containing 5 grains of quinine and 20 grains of salicylate of soda, taken in water, once in twenty-four hours.

During the attack the person should be kept quiet in a darkened room, with head raised, and the frequent application of iced cloths made use of.

Vertigo (giddiness, swimming in the head) is an impression of things whirling round, and may pass off speedily, or may cause the patient to stagger and fall.

It is a symptom rather than a disease. It accompanies disease of the brain, and a special disease of inner parts of the ear (Ménière's Disease). Sometimes it is a mere indication of a passing disturbance in the circulation of the blood in the brain, sometimes the result of an unhealthy condition of the blood. It may be almost the only symptom in mild cases of epilepsy. It also is very often dependent upon digestive disorder, and *will very often be found to be due, in women of the working-classes, and girls kept busy all day in warehouses, to excessive tea-drinking, want of regular nourishing diet, and consequent indigestion and flatulence.* Women are also subject to it at the monthly periods, and on the occasion of any sudden stoppage of them, or during "the change of life."

The use of opium, and excess in alcohol, or specially tobacco, will produce it.

The treatment is indicated by the cause. Set the indigestion or flatulence right, and attend to other obvious things. If flushings of the face accompany it, use purgative medicines, mineral waters, wholesome but not too rich diet, and exercise. Cease excess in drugs or tobacco. If the symptoms persist, consult a physician and have *the ears and nose carefully examined.* Only a physician is capable of arriving at the cause.

SOMNAMBULISM, SLEEPLESSNESS, AND NIGHTMARE.

One of the characteristics of all living things is their *periodicity.* Thus plants have their period of activity, culminating in the production of flower and fruit, and their period of inactivity during which they appear quite without life and sap. Not only have they their annual periods of activity and inactivity, but also daily periods, their alternations being so largely dependent upon light and heat. Thus while ordinary flowers flourish mainly during the daytime, the night-flowering cactus blooms and emits its perfume during the night. Animals also exhibit this periodic character. Most notable examples are the hybernating animals, who with the coming of winter's cold are subject to a remarkable diminution of their bodily processes, so that they pass the winter in a condition of unconsciousness, waste being reduced to the lowest, and the bodily function being just performed sufficiently to maintain the spark of life, which the return of heat reanimates into a flame. Human beings also present many instances of a periodic character. The chief is undoubtedly exhibited by the heart. This organ might seem at first to be perpetually active during the whole of a person's lifetime; but it is not so. The movement of the heart is rhythmic, the rhythm consisting in regularly alternating periods of work and of rest. Thus, at the close of each contraction of the heart, signified by the beat against the chest wall, there is a pause, and the period of contraction is in the proportion of $\frac{3}{5}$ths to that of the rest, which is $\frac{2}{5}$ths; the heart, that is to say, works $\frac{3}{5}$ths of its time and rests $\frac{2}{5}$ths. Similarly after every expiration from the lungs there is a pause before the next inspiration begins. These periods of rest are necessary for the continued vigour of the organs. The heart that was kept in such a state of excitement that it had little or no intervals between its contractions would be speedily exhausted, and would require to cease its work altogether. It is undoubtedly during the periods of repose that the energy expended in the immediately preceding activity is mainly renewed, and consequently, if, through want of the repose, the needed replenishment of energy did not take place, exhaustion would speedily follow. Now sleep is just another manifestation of this periodic character of living processes. Sleep affords the interval during which nervous energy expended during the waking hours is renewed. In the waking state the mind is being constantly appealed to. From all sides, by means specially of eye, ear, nose, and other sense organs, demands are made upon the attention of the brain, and during this waking state there cannot be a moment when the mind is not occupied somehow or other. All this means expenditure of force, and consequent waste, which must be repaired. There therefore comes a time when this expenditure has reached a point when it is of advantage that it should cease, and the desire for sleep arises. The desire may, however, be fought, and the activity of the brain continued *by demand. This activity by demand* means a greater than usual expenditure of nerve-force, a greater than usual degree, that is, of nervous exhaustion. But it is obvious that the time will speedily come, be the stimulus what it may, when the cells that are the source of the energy can no longer respond to the demand, and sleep will supervene, no matter how resolutely it may be resisted, and no matter what objects are brought before the mind with a view to maintain its attention. Remarkable instances of this fact are given, such as those of gunner boys falling asleep during the height of an action, owing to the fatigue caused by their labours in carrying ammunition for the gunner. A case is also reported of a captain of a warship, engaged in the last attack upon Rangoon, falling asleep, and remaining so for two hours beside one of the largest guns of his ship, the gun being served vigorously all the time. Instead of sleep supervening, however, it often happens that, when sleep has been kept off by great mental effort or strain for a considerable time, a condition of irritability is set up which prevents the access of sleep when it is at length desired. Business men, literary men, students, who night after night occupy themselves with business cares or studies far beyond the usual hour of retiring, are apt at length to produce a condition of extreme excitability and restlessness, which prevents them going to sleep without delay when at last they do retire, and which prevents the sleep being either refreshing or restoring. This is properly an abnormal condition, a condition upon the very borders of disease, if not actually disease. It indicates the revolt of the nervous centres to the treatment they have received, a revolt which may pass into something very much worse if the cause of it be not speedily done away with.

It has been said that during our waking hours the mind is kept incessantly active by the demands made on it through the senses. Naturally, therefore, sleep is most readily obtained when the avenues of sense are closed, so that the mind is cut off from the distractions that throng upon it. Thus the closing of the eyes, and darkness, cut off distractions conveyed by the organs of sight, and with silence the ear is powerless to stimulate. It is recorded of a boy who had only one eye and one ear that were of any use, and who, owing to disease, was otherwise insensible to impressions from without, that the closing of his eye and the blocking up of his ear speedily put him to sleep.

The condition of the brain during sleep is one of considerable bloodlessness. There seems to be both a diminished quantity of blood circulation through the brain, and the speed of its movement is lessened; whether this is the cause of sleep, or is the result of diminished activity of the organ—less demand and consequently less supply,—it is difficult to say. Probably it is rather an effect than a cause of sleep.

In sleep, then, the mind is cut off from the outside world. The question has arisen whether this is all, or whether sleep implies not only the interruption to the conveyance of stimuli to the mind by the avenues of sense, but also interruption to the activity of the mind itself. In a word, does the mind sleep too, or does it wake? On the answer to this question depends the explanation given of many very complicated and interesting facts, such as those of dreaming and somnambulism. Many maintain that the mind is quite inactive during sleep, when the sleep is good. If the mind is quite inactive during ordinary profound sleep, there can, of course, be no dreaming, since that implies an activity of the mind. So those who believe profound sleep to mean complete mental inaction, believe dreaming to be the mark of imperfect sleep, and to occur, therefore, when sleep is light, and specially in the stage between sleeping and waking. The main feature of dreaming is that however active the mind may be the will is in abeyance, and ideas and imaginations throng through the mind without let or hindrance in uncontrolled disorder. They are ideas with which the mind has been previously occupied, and which come up perhaps accompanied with their old associates, perhaps with other old ideas, not, however, formerly associated with them. They are frequently suggested by external circumstances, a sound setting up a rapid train of ideas which rushes across the mind in the interval before the person is awakened by it. Or the suggestion may come from within—the pains of indigestion setting up dreams of terror, coldness of some part of the body suggesting to the sleeper that he has fallen into the water, and so on. Nevertheless it has happened that intellectual processes of a high order have been carried on in dreams. Opposed to the view that the state of mind during sleep is one of inaction, is that view which holds that the mind is always active, and that in sleep we are always dreaming, but that we do not remember our dreams unless we awake in the middle of them. It is the memory that is defective and fails to recall our dreams. This view offers a simple explanation of dreaming and of somnambulism.

Somnambulism is distinguished from dreaming by the fact that, while a person may recall his dreams, the somnambulist has no recollection of anything said or done during sleep. Somnambulism may be in the very simple form of talking in the sleep, or may amount to getting up, walking about (this is what the word implies—sleep-walking), and engaging in various kinds of activity. Cases are recorded of men rising in sleep, dressing, and going out to their workshops or offices, of mathematicians working out obscure problems which had baffled them when awake, of lawyers writing out just and accurate opinions on difficult and intricate points of law, concerning which they had been unable when awake to form a decision, of poets writing some of their most delightful verses, of musicians composing their most successful pieces, and of persons discovering articles that had been laid aside and the place forgotten. The credibility of such feats is denied by some eminent men, and yet instances are given of such things being done. More than that, there are credible records of as marvellous feats being performed by persons who developed their power during attacks of madness, and of people displaying, during attacks of delirium due to fever, powers formerly unknown to themselves, and powers they no longer possessed when the delirium had passed. Thus Dr. Rush, an American physician, has recorded of a female patient of his who became insane after childbirth, in the year 1807, that she "sang hymns and songs of her own composition during the latter stage of her illness with a tone of voice so soft and pleasant that I hung upon it with delight every time I visited her. She had never discovered a talent for poetry or music in any previous part of her life. Two instances of a talent for drawing," he adds, "evolved by madness, have occurred within my knowledge." Coleridge in his *Biographia Literaria* (p. 54, ed. 1870) relates the following case, which "occurred in a Catholic town in Germany a year or two before my arrival in Göttingen, and had not ceased then to be a frequent subject of conversation. A young woman of four or five and twenty, who could neither read nor write, was seized with a nervous fever, during which, according to the asseverations of all the priests and monks of the neighbourhood, she became possessed, and, as it appeared, by a very learned devil. She continued incessantly talking Latin, Greek, and Hebrew in very pompous tones, and with most distinct enunciation. . . . The case had attracted the particular attention of a young physician, and by his statement many eminent physiologists and psychologists visited the town and cross-examined the case on the spot. Sheets full of her ravings were taken down from her own mouth, and were found to consist of sentences, coherent and intelligible each for itself, but with little or no connection with each other. Of the Hebrew a small portion only could be traced to the Bible; the remainder seemed to be in the Rabbinical dialect. All trick or conspiracy was out of the question. Not only had the young woman ever been a harmless, simple creature, but she was evidently labouring under a nervous fever. In the town, in which she had been resident for many years as a servant in different families, no solution presented itself. The young physician, however, determined to trace her past life step by step; for the patient herself was incapable of returning a rational answer. He at length succeeded in discovering the place where her parents had lived; travelled thither, found them dead, but an uncle surviving, and from him learned that the patient had been charitably taken by an old Protestant pastor at nine years old, and had remained with him some years, even till the old man's death. Of this pastor the uncle knew nothing but that he was a very good man. With great difficulty, and after much search, our young medical philosopher discovered a niece of the pastor's, who had lived with him as his housekeeper, and had inherited his effects. She remembered the girl; related that her venerable uncle had been too indulgent, and could not bear to hear the girl scolded; that she was willing to have kept her, but that after her patron's death the girl herself refused to stay. Anxious inquiries were then, of course, made concerning the pastor's habits; and the solution of the phenomenon was soon obtained. For it appeared that it had been the old man's custom for years to walk up and down a passage of his house, into which the kitchen door opened, and to read to himself with a loud voice out of his favourite books. A considerable number of these were still in the niece's possession. She added that he was a very learned man, and a great Hebraist. Among the books were found a collection of Rabbinical writings, together with several of the Greek and Latin fathers; and the physician succeeded in identifying so many passages with those taken down at the young woman's bedside, that no doubt could remain in any rational mind concerning the true origin of the impressions made on her nervous system."

Dr. Abercrombie relates cases where attacks of somnambulism came on, not during night, but during daytime. During the attack, which lasted some time, then passed off, and at some later period returned—during the attack the persons were abstracted, and could do what was impossible to them after the attack passed off. One patient was an educated young lady who, on recovering from her first attack, found she had lost all her former knowledge, and set to work to regain it. She was making progress when she was seized with a second, which left her with her former state of knowledge quite restored. This alternation went on for four years, one attack leaving her without her former knowledge, and the next restoring it. In this case there was shown what is called **double consciousness**, that is, things or persons that may have been seen, or things that may have been heard, during an attack were not remembered when the attack passed off, but were recalled during a succeeding attack. In the same way, anything seen or learned in the interval between two attacks was entirely forgotten in succeeding attacks, but was easily remembered in the intervals.

Thus, during somnambulism mental processes of a high character may go on, but they leave no recollection behind them.

A curious circumstance is that a person walking in sleep will move round obstacles in his path, and guide his course just as if he were fully awake and fully conscious of all his movements. This may be explained by reflex action (see p. 132), the objects making impressions on the eyes, and those impressions through the nervous ganglia at the base of the brain stimulating in a habitual way certain centres for movement. Often, however, somnambulists walk into dangers that cause their death.

The ordinary forms of sleep-talking and sleep-walking are common enough in children.

The treatment of such conditions must largely depend on the person, whether child or adult. Anything that over-excites should be avoided, whether over-feeding, or feeding with too rich diet, or over-exercise, or over-study, or the over-excitement of pleasure. At the same time it must be looked to that the person, and especially the child, is not given to very deep slumber because of poverty of blood, and consequent insufficient nourishment of the brain for its healthy activity. Means should be taken if possible to prevent the occurrence of sleep-walking by awaking the person during the night. If the tendency is to walk at a certain time, this will be especially beneficial by anticipating the period, and so gradually weakening the habit. Children of this tendency should never be allowed to sleep alone; and in all cases precaution should be taken to prevent a sleep-walker from opening windows, outer doors, &c.

For children, bromide of potassium, in 5-grain doses, at bed-time, is specially valuable in allaying any excitable condition from which the disorder may spring.

Sleeplessness (Insomnia) is of many kinds, from absolute wakefulness, accompanied by a busy brain, probably the result of it, to the dull stupor that is not true sleep, or the broken fitful snatches disturbed by dreams and fancies, generally of a disagreeable sort. Like headache, it has a variety of causes. Overwork and worry is a common cause. The business or professional man, especially one who has to sit late busy with books or ideas, if he goes straight off to bed, very likely sleeps little or badly. Similarly, the woman who has many engrossing household cares, and who, with running about and directing affairs, is intensely fatigued, is likely to pass a night that, with sleep or without it, will probably prove unprofitable in the morning. Badly ventilated apartments can provoke it. Indigestion, constipation, and heavy suppers are well known hindrances to sleep.

Treatment.—It will be found that quiet rest without work of any sort for an hour at least before retiring is the best preparation the exhausted business man, brain worker, or housewife can have for bed. Every clergyman who has had an evening service knows that if he wishes to sleep he must let some of his excitement work off before going to bed, and he usually aids its departure with a quiet smoke and talk by the fireside. To a mild smoke to the man accustomed to it there is no possible objection. Brisk evening exercise in the open air, the use of the cold bath, or the mustard foot-bath, to draw the blood from the head, may be tried. Treatment by the high-frequency electric current is well worth a good trial.

None of these methods is of any avail to many people, and meanwhile the sleeplessness becomes painful, exhausting, or killing. Some drug must be resorted to; which should it be? **Not opium, and not chloral hydrate.** The use of both of these grows perniciously. The man who accustoms himself to his nightly dose of opium requires increasingly larger and larger doses, and soon begins to use the drug for relief from other troubles. Chloral hydrate, too, gains a wretched mastery, and has had its countless victims found dead in the morning, because in their confidence in its use an overdose had by mistake been taken. Again the safe drug is bromide of potassium—30-grain doses in a wine-glassful of water. Failing it, one of the newer remedies, trional or veronal, may be employed. [Refer to section on HYPNOTICS.] Wakefulness as the result of indigestion is to be treated by the removal of the cause.

Nightmare is a condition of nervous activity that occasions dreams of a very vivid and usually distressing character. The anguish of the situation is increased by the want of voluntary power, and the inability to move or cry out. When this is at last, after a seemingly intense struggle, effected, the person awakes. In children nightmare—night-terrors as it is sometimes called—occurs, in which the child wakes up some hours after going to sleep, in great fright.

Treatment.—Nightmare is very frequently due to errors of diet. The bowels should be relieved by ordinary purgative medicine, such as castor-oil. If the child be specially nervous the bromide of potassium, 5 grains in a tablespoonful of water at bedtime, may be given.

Hysteria, Catalepsy, and **Trance** are discussed in Section XXVIII.

Neurasthenia, meaning nerve weakness, is a word coined in 1869 by an American physician named Beard, for a condition characterized by rapid exhaustion of physical or mental effort and by irritability of the senses and of the mind. It is too complicated a subject to be dealt with here, but the word is too often used to explain a nervous state caused by some internal ailment which has been overlooked because not properly searched for.

DISEASES OF THE SPINAL CORD.

Inflammation.—It has been pointed out (p. 137) that the spinal cord consists, like the brain, of white and gray nervous matter, arranged in a particular way, and enveloped in membranes. It too has its supply of blood for its growth and vigour. The cord, consequently, will be liable to inflammations of its own substances, or inflammations attacking its membranes. As similar affections attacking the membranes of the brain are called Cerebral Meningitis, so those of the spine are called **Spinal Meningitis.** Inflammation of the substance of the cord itself is called **Spinal Myelitis.** It is sufficient to mention these names, and quite unnecessary to detail the symptoms. The affections are not so common as to require description in a work of this kind, and besides, the determining of their presence is a work of difficulty for even skilled physicians. The diseases are associated with pains of various kinds and with paralysis.

Inflammation of the cord, however, may be set up by injuries, or by exposure to cold and wet, and manifests itself by fever, intense pain in the back, and paralysis of the lower limbs. In such cases relief may be obtained by the use of leeches and hot applications. The paralysis may remain after the inflammation has passed away, requiring the use of blisters, friction, electricity, &c., conjoined with nerve tonics, to restore the function.

Degeneration of the cord is the general cause of various kinds of paralysis. In one form of degeneration the breaking down of the nerve-cells and wasting of nerve-fibres is associated with an increased formation of other forms of cells and fine connective tissue, so that the part of the cord subject to these changes is deprived of its natural structure and becomes hardened. This condition is called **sclerosis** (Greek, *sklēros*, hard).

Congestion of the cord is usually of a chronic form, occurring in old people. It is attended by rather vague symptoms, among which are aching back and limbs, and diminished muscular power, especially of the lower extremities. Its treatment should be conducted with friction to the spine, and the use of tonic medicines and nourishing food.

Spinal Irritation is a phrase of frequent use, and yet it is difficult to say whether it signifies any special disease.

The **symptoms** which are included under the phrase are various: pain or tenderness in various parts of the body, a feeling of constriction of the chest, a sensation of a lump in the throat, cough, palpitation, and specially constant sickness and vomiting. These occur usually in hysterical girls. On tapping with the knuckle down the back over the spines of the vertebræ a place is reached where there is distinct shrinking by the patient from the stroke. On testing again by passing hot and cold sponges alternately down the spine, shrinking occurs when the sponges pass over the special spot. It is to be observed that the tenderness is invariably *over a spot.*

The treatment of spinal irritation consists in the application of blisters over the painful spot. Even a single blister is in many cases followed by very considerable relief. There should be added the use of nourishing food, quinine and iron tonics, rest, and change of air, the general treatment being directed to the removal of the hysterical condition, which, in most cases, is at the root of the trouble.

Concussion of the spinal cord is the result of shock, such as that due to a fall, a throw from a horse or gig, or shock received in a railway collision, &c.

The symptoms are often very vague. For instance, after recovery from the immediate shock of a severe shake in a railway accident, the person may feel comparatively well. After some days, however, even weeks, insidious symptoms may appear, tingling sensations, numbness or coldness of the limbs, loss of power, difficulty in walking, and perhaps ultimately paralysis. Unfortunately, owing to the considerable amount of money frequently obtainable in name of damages for such injuries, there is great temptation for dishonest persons to feign these and similar symptoms, even to the paralysis. It is very difficult for surgeons to express a decided opinion, just because the symptoms are subjective, that is, reveal themselves to the patient only. One test, however, is frequently applicable, that of electricity, which in such cases is capable of revealing with certainty the presence of actual changes in the healthy condition of nerves and muscles.

The treatment adopted by a person who has received such a shock ought to be to get to bed as quickly and quietly as possible. Absolute rest may prevent the development of any inflammatory processes. Any further steps should be taken only with medical advice.

Spina Bifida. Refer to DISEASES OF CHILDREN.

PARALYTIC AND CONVULSIVE DISEASES.

PARALYSIS.

Paralysis comes from a Greek verb meaning to relax or disable at the side. Paresis and palsy are terms also used to imply the same condition of loss of power. The paralysis may mean loss of power of moving, or loss of power of feeling. In some diseases both occur, and the paralysis is said to be *perfect* or *complete.* In other diseases only one may occur, and the paralysis is said to be *imperfect* or *incomplete,* and then paralysis of motion is spoken of, or paralysis of sensation, as the case may be. Paralysis of sensation is also called anæsthesia.

Paralysis may arise from disease of the brain, disease of the spinal cord, diseases of nerves or of muscles, or may be due to poisons, especially to lead poisoning. According to the seat of the disease is the nature and extent of the paralysis.

Hemiplegia is a paralysis of motion limited to one side of the body. In it the power of moving voluntarily the muscles of the affected side is lost. It is due to disease of the brain. Now it has been mentioned (p. 150) that the corpora striata at the base of the brain are to be regarded as the centres for motion, and that when we will to move any part of the body the impulse descends from the cerebral hemisphere to the corpus striatum, and is transmitted by it down the spinal cord and out by nerves to the muscles that are to be moved. It was also mentioned that the fibres that carry such impulses from the corpus striatum cross over from one side to the other in the medulla oblongata, so that impulses from the right corpus striatum pass to the left side of the body, and from the left corpus striatum to the right side of the body. Thus any disease on the *right side of the brain,* which prevents the impulse from the will reaching the corpus striatum, or any disease which injures the corpus, or which prevents the impulse transmitted from it reaching the spinal cord, will produce paralysis—hemiplegia—of the *left side of the body,* while any disease in similar positions on the *left side of the brain* will produce paralysis of the *right side of the body.* The disease is generally due to the bursting of a blood-vessel, the blood from which forces its way among the delicate nervous structure, destroying it; or it may be due to a blood-vessel being blocked, for instance by a small clot of blood sent from the heart, a condition frequently caused by rheumatic fever, and called **embolism.** When a clot is the cause of the paralysis the area of brain substance supplied by the blocked vessel is suddenly deprived of its accustomed quantity of blood, and is thus rendered incapable of performing its duties.

Symptoms.—The paralysis may come on suddenly without consciousness being lost, the person suddenly discovering that he has lost the power of one side. It may come on with giddiness and confusion of thought, or with a severe pain in the head, or with sickness, pallor, and faintness, or with entire loss of consciousness. In some cases the paralysis is at first slight, but progresses, and passes on to unconsciousness, which may be recovered from, the paralysis of one side remaining; or it may deepen into death. In an ordinary case the one side of the body will be found powerless, though feeling remains, the same side of the face is paralysed, and the active muscles of the opposite side consequently pull the face to that side, so that the face is twisted. There is thickness and indistinctness of speech, and when the person puts out his tongue it is pointed towards the paralysed side, because one half of it is paralysed. In less severe cases some power may be left in the leg, though the arm may be quite useless. The mind may be affected, but is frequently apparently not so. In favourable cases recovery begins in the leg. Recovery may be complete, or only up to a certain point, or not at all. Instead of recovering, the paralysed limbs may become rigid, the mind enfeebled, and the body fail, so that bed-sores form. Other attacks are apt to follow the first.

Treatment consists in removing the patient at once to bed in a quiet well-ventilated room, the head being slightly raised. If he is unconscious, practically nothing can be done except to keep him undisturbed till consciousness returns. Then he is to be fed on a simple, nourishing diet, milk especially, all stimulants being forbidden. His bowels must be regulated, but not with strong medicines; an injection of warm soapy water is very useful. Nothing further should be attempted without medical advice.

Cross Paralysis is the name given to the paralysis of one side of the body and the opposite side of the face. It indicates that the cause of the paralysis is situated towards the base of the brain.

Paraplegia is the term applied to paralysis proceeding from disease of the spinal cord. The extent of the paralysis naturally depends on the level in the spinal cord where the disease exists. If it be low down, the functions of the bowels and bladder are interfered with, and the legs are paralysed; if it be much higher up, the muscles of the trunk are also involved, and the upper limbs. Usually it is the lower half of the body that is affected. Both motion and sensation may be paralysed, or owing to a peculiar distribution of the disease in the cord motion may be paralysed on one side and sensation on the other.

The **symptoms,** thus, generally include paralysis of the lower limbs, and involuntary discharges from the bowel and bladder. While the person cannot move his legs by the power of his own will, they may move involuntarily and start spasmodically because of reflex action (see p. 132).

The **treatment** depends on the cause of the disease, which may be inflammatory action in part of the cord, effusion of blood into the cord, disease of the vertebræ, want of due supply of blood to the cord, syphilis, and other causes. This it is often difficult to determine.

Till competent advice can be obtained the patient is simply to be kept clean and dry, and to be given simple, nourishing diet. Deep sores are apt to form, and to guard against this, watchfulness is necessary.

Aphasia (Greek *a*, not, and *phasis*, speech) is the term first used by the French physician Trousseau to denote loss of the power of speech due to disease of the brain, and not to paralysis of the organs of speech. It has various forms difficult of distinguishing. One form has been called **aphemia** (*a*, not, and *phēmi*, I speak), in which the person has lost the power of willing the combined movements which go to produce speech. At the same time he can read to himself, write, and understand what is said to him, but cannot himself produce the movements that will enable him to express himself. In another form, called **amnesia** (*a*, not, and *mnēmē*, memory), the person loses memory of words, so that he cannot speak, nor read to himself, nor write. He may retain a few words, which he employs indiscriminately. He can repeat words dictated to him, and seems to understand what is said. In **agraphia** (*a*, not, and *grapho*, I write) there is loss of power to write, not from paralysis of the hand or fingers, but from inability to express ideas in writing. At the same time the person may be able to read and speak, but when he or she tries to write, jargon is the only result, though the letters can be formed quite distinctly and properly. These affections, all grouped under the name aphasia, were attributed by the late M. Broca of Paris to disease situated in a special region on the left side of the brain in front. The disease is sometimes transitory, being due to slight congestion of part of the brain, occurring after long illnesses, more especially fevers. Much more frequently, however, it is partially or entirely permanent, caused by apoplexy, softening of the brain, or the pressure of a tumour. Sometimes aphasia occurs alone; at other times it is accompanied by paralysis of one side of the body, generally the right side.

The treatment demands the aid of a physician, and consists in attention to the bowels, the use of good easily-digested food, avoidance of all excitements, and the employment of tonics, such as iron, quinine, and strychnine.

Local Paralysis is the phrase used to signify that one muscle or a group of muscles is affected. It does not spring from disease of the brain or spinal cord, but from some disease of, or injury to, a particular nerve-trunk. An accident, for instance, to an arm may have so bruised or otherwise injured one of the nerves that it is cut off from its centre in the cord, and consequently wastes. The muscles to which this nerve proceeded are consequently deprived of its influence, and are therefore paralysed. In fracture such an injury might be caused by the ragged ends of the broken bone. A tumour pressing on the nerve might produce the same results. If a sensory nerve is involved, then the region of skin supplied by that nerve is devoid of sensibility. The trouble of such local paraylsis is that the muscles, deprived of their nerve supply, speedily waste, lose their power of responding to a stimulus, and become weak and soft. Facial palsy is an example of this kind of paralysis.

Facial Palsy, paralysis of one side of the face, is due to some affection of the part of the seventh cranial nerve (p. 152) which confers movement on the muscles of the face. This affection of the nerve may occur in any part of its course from the brain to the muscles of the face. The common form, and the form which it is desirable to note in this place, is frequently due to cold caught by a person sitting in a railway train at the side of an open window and facing the engine, so that the draught blows on one side of the face. It has been mentioned that one half of the face is paralysed in hemiplegia, but this paralysis of the face differs from what is called facial palsy in the completeness of the paralysis in the latter case as shown by the symptoms.

Symptoms.—One side of the face is motionless, quite smooth, unwrinkled, and soft. The patient cannot shut the eye of one side, the eyeball is consequently exposed continually, dust may lodge on it, and thus a state of constant irritation is set up, and the tears flow over the cheek. The person cannot whistle or blow out a light. When he tries, the paralysed cheek is simply blown up with the air. When he eats, food is apt to lodge between the gums of the affected side and the cheek, and is productive of great annoyance. Sometimes the hearing and taste are affected. The brow is smooth on the palsied side, and when the patient wrinkles his brows only the healthy side is thrown into furrows. The face is drawn to the healthy side by the action of the muscles of that side. When the person tries to laugh or make a grimace the result is very ridiculous, one side responding and the other being absolutely smooth. Now in paralysis of the face, due to hemiplegia, the eye and forehead usually escape.

Besides cold, rheumatism, inflammation of the ear, and decayed teeth may cause this affection.

Treatment.—Let the patient be sure that rheumatism, ear or tooth affection, is not present to account for the paralysis. If it is believed to be due to cold, the probability of recovery is great, but not for a few weeks or perhaps some months. If it is due to cold, the speedy application of leeches on the bone immediately behind the ear, and, after it, blisters, hot fomentations, &c., are recommended. Later the most beneficial treatment is with electricity, which, even after the lapse of considerable time, will restore the nourishment and tone of the muscles, and has great chance, with patient use, of ultimately restoring voluntary movement. Let it be observed that electricity does not mean magnetism, and that the use of magnetic belts, collars, &c., are absolutely valueless. The electricity to be used is either that obtained directly from a galvanic battery, or the kind called induced electricity, obtained by sending a galvanic current round a specially constructed coil of wire (induction-coil), and the electricity should be directly applied to the paralysed muscles.

There are several varieties of paralysis due to degenerations going on in various portions of the spinal cord. Some of these will be briefly described, others will only be mentioned.

Locomotor Ataxy (Greek *a*, not, and *tasso*, to order) is a peculiar disease, so called because sufferers from it cannot order their movements for definite purposes, so that walking is difficult, and there is a peculiarly awkward gait.

The **symptoms** are specially connected with movement. The person needs to guide the movements of his feet and legs by means of his sight, so that if his eyes are shut, or if he is in the dark, he loses balance, and cannot go at all. When he walks, his feet are lifted up extravagantly high and jerked out and brought down in a violent way. This difficulty of movement is called "want of co-ordination of movement." In advanced stages it becomes so extreme that the person cannot take even a couple of steps, and is confined to his bed or chair, and this although there is plenty of muscular power in his limbs, and although he can move them easily enough when lying in his bed. Associated with the difficulty of movement is a peculiar tingling and numbness and loss of sensibility in his toes and feet, so that he feels as if he were walking on some thick soft material. These are the most striking symptoms when the disease is developed. For some time previous to this, however, perhaps even for years previously, there may be what are called premonitory symptoms. The chief of these are shooting and boring pains affecting the trunk and lower limbs. There are also feelings of constriction and pains connected with the abdominal organs, especially intense pains in the stomach. There are also affections of various other parts of the body, joints, ear, and eye. There may be squinting, double vision, defective sight. In particular the pupils of the eye are very small. The disease extends to the hand and arm, and their movements are affected, the clumsiness of movement being remarkable.

The **causes** of the disease are not well known. Sexual excess, exposure to cold, over-exertion, syphilis, are all said to be causes. Its progress is very slow, extending often over many years, and recovery is rare. It is not common in women.

The **treatment** consists mainly in measures for maintaining the general health. Nothing is as yet known to have any permanent benefit.

Shaking Palsy (Tremor—Paralysis Agitans) is characterized by tremulousness of muscles quite apart from any effort at movements. When developed, the trembling is incessant, affecting several limbs. It does not stop during sleep, and may be sufficient to prevent sleep. In walking, the patient usually bends head and trunk in advance, and then runs straight forward, as a man trying to regain his balance. The muscles tend to become rigid and cramped, and great restlessness is exhibited.

Treatment is as hopeless as that for the preceding paralysis.

Wasting Palsy (Progressive Muscular Atrophy—Creeping Palsy) is attended with loss of muscular power, and, associated with the loss of power, wasting of the muscle. It generally begins slowly, attacking one muscle, or a group of them, the muscles of the ball of the right thumb being usually first affected, then the muscles opposite—those of the little finger. The wasting gives the hand a claw-like look. Then the disease passes up the limb, from forearm to upper arm and shoulder, then on to the trunk, afterwards invading the lower limbs. The course of the disease is slow, unless the muscles connected with breathing and swallowing become affected early, when choking or difficulty of breathing is liable, with attendant troubles, to cut off the patient in two or three years.

Among its causes, exposure to cold and wet are mentioned as chief. It attacks children, however, sometimes, and appears in them to be hereditary.

The chief **treatment** is with electricity, which seems to do good by so acting on the muscles as to restore their nutrition and arrest wasting.

Pseudo-hypertrophic Paralysis is a paralysis occurring in children, and especially boys, and attended with apparent increased growth of muscles, particularly of the calves and buttocks, The increased growth is only apparent, however, the muscular fibres actually dwindling, while the increased size is due to fat and connective tissue between them. Feebleness of the muscles of the legs appears to be among the early symptoms, and the boy walks with legs kept apart and shoulders thrown back. The affection of the muscles, which begins low, passes upwards, affecting muscles of back and trunk, arms and face. As the bulk of the muscles increases, the waddling movement of the child is more pronounced, he has great difficulty in getting up, and is constantly falling. With the enlargement, the weakness of the muscles keeps pace, till the child becomes helpless. Death usually occurs before eighteen.

No treatment is of any avail if the disease has reached the stage of muscular enlargement. Before that period electricity seems the main remedy.

Infantile Paralysis occurs in children during the second year of life, but may be any time between birth and ten years of age. Like the other forms, exposure to cold is said to be a frequent cause, teething being also set down as favouring its occurrence.

The **symptoms** begin with fever, accompanied now and again with convulsions. The paralysis, which affects motion only, not sensation, occurs quickly, and increases rapidly, sometimes arms and legs being attacked, sometimes only groups of muscles in them. The muscles rapidly lose their power, become relaxed and cold. After some time—two to six months—some improvement may take place. Later, however, owing to the irregular wasting of the muscles, or the unequal recovery, deformities result, mainly of the hand and foot. Frequently also the bones of the affected part cease to grow.

The **treatment**, while the attack of fever lasts, is simple, attention to procure movement of the bowels, and the giving of light diet. The use of electricity is highly commended in the later stage, to prevent the rapid wasting of muscles and to restore those already wasted.

Lead Palsy, in which the paralysis is usually limited to the extensor muscles of the forearm, specially the right, is one of the commonest symptoms of *chronic lead poisoning.* The lead poisoning may arise from many circumstances—workers in white-lead manufactories, painters, plumbers, those engaged in glazing pottery where oxide of lead is used, makers of some kinds of glazed cards, bleachers of Brussels lace, are all liable to it. It is those who work among preparations of lead, however, and not those who work with the metal itself, that are most liable. Lead may be taken into the system also in drinking water which has lain in leaden cisterns or leaden pipes. Hard waters which contain sulphate and carbonate of lime act less readily on lead than soft waters. Lead poisoning has been due to drinking wines contaminated with the metal, and to the drinking of Devonshire cider made in leaden vessels. The use of cosmetics containing lead has also been productive of harm.

The **symptoms** of lead poisoning, besides paralysis, are general ill-health, sallow complexion, metallic taste in the mouth, the formation of a blue line along the edges of the gums next the teeth, and colic and vomiting. The paralysis affects particular muscles, so that the person cannot extend the back of the hand, *the wrist consequently drops,* and cannot be raised. The affected muscles waste, and a hollow appears on the back of the forearm. Other muscles—those of the shoulder and back of the arm—occasionally suffer.

Treatment consists first of all in removing the person from the source of the poison, which should be carefully investigated. Those who engage in lead works, or in works where lead is largely used, should cultivate strict cleanliness, and should use the tooth-brush to get rid of any of the dust that may adhere to the teeth and gums. For the colic and vomiting, 10 grains of calomel and 1 to 2 grains of opium are given, followed by a dose of castor-oil, and warm fomentations are applied over the abdomen. Iodide of potassium given internally in small quantities (1 to 3 grain doses) is believed to remove the lead from the system. For the paralysis, electricity is the only remedy of value.

Paralysis of Sensation is technically called **anæsthesia.** It also may be due to disease of the brain, or of the spinal cord, or only of the nerves supplying the affected part. It must be remembered that sensation is a mixture of several things. There may be a sensation of mere touch—tactile sense,—or there may be a feeling of pain—pain sense,—or a sensation of heat or cold—temperature sense,—or a sensation of pressure or resistance—muscular sense (see p. 444). In complete anæsthesia all these are abolished. Any injury, for instance, destroying or cutting through at any point the posterior half of the spinal cord, would abolish all sensation below the level of the injury. But injury limited to the posterior half of the spinal cord would abolish all sensation below the level of the injury, but only of that half of the body. But a disease of still more limited extent might exist in the cord, which would abolish all sensation, but only in a portion of the body of that side below the injury, a patch of skin only being so affected. Nay! disease in the cord might be still more limited, so that not only was a small portion alone of the skin involved, but so that only the sense of touch, or the sense of pain, or the sense of temperature, or the muscular sense was involved, the other sensations being preserved. Thus a patient might have such a limited disease of the cord that only the sense of temperature was destroyed in, let us say, one or two fingers of the right hand. The person might grasp a hot poker, and might be aware, by sense of contact or touch, that he was grasping the poker, but might not perceive that it was hot, and would thus be burnt. The sense of pain might at the same time be preserved, and then the person would become aware of the burn by feeling the pain, but by that time the injury would be done.

Just as it is possible, in cases of paralysis of motion, to determine where the disease is probably situated because of the situation and extent of the paralysis, so, in cases of paralysis of sensation, accurate observation of the character of the sensory paralysis and its extent will often enable one to decide in what part of the nervous system the disease is situated. It would be to that part, of course, that treatment would be directed.

Like paralysis of motion in brain disease, there may be paralysis of sensation affecting all of one side of the body. This is called **hemi-anæsthesia.**

When sensation is abolished in a part of the body it means that the portion of the nervous system related to that part is destroyed by the disease. But such disease may in its earlier stages only irritate that portion. In this case sensation would be affected, modified in some way, not abolished. The irritation might, for instance, increase the sensitiveness of the part. This is called **hyperæsthesia.** Or, instead of increased sensation, some unusual sensation might be experienced in the part, as the result of the irritation. This is called **paræsthesia.**

CONVULSIVE DISEASES.

Convulsions may be simply an incident of a disease, as in epilepsy and hysteria, or they may be the disease in themselves. As an independent ailment they affect both grown-up people and children, but the latter are specially liable to them because of reasons that will be explained in dealing with convulsions occurring in children. (See DISEASES OF CHILDREN.) They occur in women associated with pregnancy or childbirth. (See DISEASES OF WOMEN.) They consist in violent contractions of the muscles of the body, and are beyond the control of the will. Sometimes the spasm remains for some time, and the affected muscles are felt to be rigid; at other times the spasm quickly relaxes and then recurs, so that jerking movements are produced. The former is called **tonic** spasm, the latter **clonic** spasm.

The **causes** of convulsions in adults (those of children will not be dealt with here) are various. Affections of the brain, such as inflammation, tumour, and injury, will produce them. Great loss of blood, producing sudden great deficiency of blood in the brain, causes them. Besides these, poisons may give rise to them, whether the poisons have been introduced into the blood from without, such as strychnine, the poison of syphilis and hydrophobia, or whether they have accumulated in the blood from disease of organs, as, for example, from disease of the kidney, preventing that organ from separating certain waste substances from the blood.

The **symptoms** are chiefly the sudden spasmodic movements of the muscles, either all the muscles of the body or groups of them only—the muscles of one side, of one leg or arm, of the face. The spasms may be slight or severe, and unconsciousness, more or less complete, attends them. Distortion of the face, staring eyeballs, or eyeballs drawn to one side, grinding of the teeth, wideness of pupils of the eyes, which are not affected by light, are some of the symptoms that may occur. The gravity of the case is dependent on the cause.

The **treatment** also depends on the cause, which it is often difficult even for a physician to ascertain. All that others can do is to place the person in bed, and loosen the clothing. To save the biting of the tongue, a piece of cork, or the handle of a horn spoon, should be placed between the teeth. Nor yet can a mistake be made by securing a speedy movement of the bowels, obtained readily by an injection of salt and water. (See ENEMA.) Cold water or ice may be applied to the head, and warmth to the feet and over the stomach. This is all that can be done till the cause of the convulsions is ascertained, which will determine the further treatment.

Epilepsy (falling-sickness, Greek *epilepsia*, a seizure) is a disease of which, in its fully developed form, convulsions, attended by complete unconsciousness, are the prominent feature.

The **causes** of the disease are not accurately known. It is certain, however, that the tendency to epilepsy runs in families, along with other nervous diseases, such as insanity, hysteria, and St. Vitus' dance. Cases have been attributed to excesses in drink and in other directions, and in children to fright. Whether fright can actually produce it may be questioned, but at least the disease may by fright be suddenly started in children who were liable to it, and who, but for the sudden shock, might have passed the danger.

The **symptoms** of a typical case are that the person becomes deadly pale, suddenly utters a horrible cry, and falls to the ground. He may be seen to be drawn to one side, his face distorted, his eyes turned up, revealing the white, and his tongue, perhaps, caught and severely bitten by the teeth. The spasm passes over his whole body, so that in a few seconds he is quite rigid, and his breathing is stopped. From the first he is quite insensible. In a very short time his face becomes swollen and congested; jerky spasmodic movements of muscles commence, the limbs being jerked, the head and mouth twitching, and the eyes rolling, the tongue probably being caught by the movements of the jaw; the breathing returns, but is noisy and difficult; froth and blood from the injured tongue escape from the mouth, and the urine may be discharged. Profuse sweating occurs, and in a little longer time, at most two or three minutes, the spasmodic movements slowly cease, the person sighs deeply, and shows signs of returning consciousness. Sensibility may return at once or slowly, and the person be dull and exhausted for some time afterwards, or a deep sleep may succeed the fit. The attack is often preceded by a warning, which may take very curious forms. In one form it is a tingling which creeps up from an extremity towards the head — the **epileptic** aura, it is called; in another case it is some pain, sense of coldness or heat starting upwards from a point of the body. To some persons the warning is in the shape of a hallucination. One patient, previous to a fit, always saw a little old woman in a red cloak. The warning may be sufficient to enable the person to get out of some dangerous position, to get down from horseback, to get off the street, &c. One man, whom the writer met, who was very subject to the attack, after a warning in the street, started to run, and ran till he could not go a step further, and so succeeded in preventing the attack. Rarely the warning is a considerable time before the attack, showing itself by depression or some change of feeling, or by excitement in the person.

Now, while these are the ordinary features of a regular fit of epilepsy, there are many attacks that can be set down as nothing else than modified fits which have yet little resemblance to the fully-developed form of the disease. One of the most notable examples of these unusual forms is where the person may become suddenly unconscious, arrest for the moment whatever work he may be engaged in, and after a few seconds resume the business he was engaged in, without being aware of any interruption. Thus a professor lecturing to his class has suddenly stopped in the middle of a sentence, his eyes looking fixedly in one direction, his hands retained in the attitude in which they happened to be at the moment, and after a few seconds has resumed the thread of his discourse, where it was left off, without any knowledge of the stoppage. French writers distinguish between the severe and mild form, by calling the former **grand mal**, and the latter **petit mal**. But the business or action with which the person is occupied need not be arrested. Thus a violinist has been known to be seized while playing, but to go on with perfect accuracy. Again, a man, working at his bench, has been known to drop his tools, on being attacked, put on his hat, and walk a considerable distance, all the time unconscious, and has wakened up to find himself seated in a public-house, quite at a loss to understand how he got there. So in other unusual forms of the disease, the person may commit not only strange but wild acts, commit an unprovoked assault in the street, be roused out of his sleep by the seizure to brutally beat his wife or dash out the brains of his child. In all these remarkable forms the features are the entire unconsciousness of the person during the attack, however guided by purpose may seem his actions, and the complete ignorance of what has occurred after the attack has passed off. The latter forms are not common, but probably the first irregular form described—that of simple momentary unconsciousness and arrest of movement—is much more common than is supposed.

Epileptic fits are commoner during night than day, especially the mild form. Thus a person may regularly suffer from epileptic attacks, which come on in bed, of which neither he nor anyone has any knowledge, and whose only indication is a feeling of fatigue and soreness felt in the morning. If the fits be of the severer form, then a swollen sore state of the tongue, and blood upon the pillow, perhaps also urine discharged into the bed, are the evidences. Death, owing to suffocation, sometimes results from epileptic attacks occurring during the night. Epileptic attacks may recur often or seldom. Sometimes a person will suffer from daily fits for some time, and then be free for months or longer, and again have a period of recurrence. They may occur not only daily, but several times throughout the day or night. In spite of their frequent recurrence, they do not immediately tend to shorten life, but they affect the patient's health and mental condition.

Treatment is often a matter of considerable difficulty, some cases stubbornly resisting all methods. The treatment during the fit is simple. Lay the patient flat on the floor, insert a pad of some sort between his teeth to prevent injury to the tongue, and otherwise let anything be done to prevent the person injuring himself. The clothing about the neck and waist should be loosened. Apart from this nothing avails anything, and one must simply wait till consciousness returns. A person liable to fits should never be in circumstances when the occurrence of the seizure might endanger his life. He should not, for instance, ride on horseback or a bicycle, or drive in a gig, nor be sitting beside a fire in such a way that he might fall into it, nor walk along dangerous pathways, or go out boating or fishing alone.

Much may be done to diminish the liability to the attacks by general treatment. Good easily-digested food, fresh air, moderate exercise, abstinence from exciting foods, drinks, exercises, *or amusements*, especially abstinence from sexual excesses and degrading habits connected with them, should be the rule. Moderation in all things will aid much his general bodily and mental strength.

Whatever be the ultimate cause of epilepsy, and the ultimate cause is yet doubtful, it is certain that a fit may be determined in a likely person by some irritation, for instance in a child by irritation in the bowels due to worms, and in a woman by irritation connected with the womb. Such irritating causes must, therefore, be removed by appropriate treatment. This, however, only treats the tendency to the disease. For the disease itself a vast number of drugs have been tried—opium, arsenic, zinc, digitalis, &c. Undoubtedly the two most useful are bromide of potassium and belladonna, the latter urgently recommended by M. Trousseau, the distinguished physician of Paris. The former is given in doses from 5 (for children) to 30 (for adults) grains in water thrice daily, and it will be found useful to give it with half to one tea-spoonful of aromatic spirit of ammonia (sal volatile); the latter is given in pills containing (for an adult) $\frac{1}{5}$th grain of belladonna extract, and the same quantity of the powdered leaves, one at night or in the morning according to the usual time of the fit. One pill is to be given daily for the first month, then two for the second month, three for the third, and so on till five and even more are taken daily. Both remedies should be continued for a long time. If the use of these drugs has held the disease in check, then after some months probably a pill containing $\frac{1}{50}$th grain of phosphorus would be of value in the way of restoring nerve tone. A very useful remedy is ordinary borax, 10 grains given in water thrice daily. It is necessary to state that a distinguished German professor, Schroeder Van der Kolk, believed the disease to be seated in the medulla oblongata, and to be due to chronic irritation and congestion. The treatment he urged as of most advantage in old cases was cupping the neck and the use on the neck of issues, and specially setons, continued for a long time. These remedies he believed acted by withdrawing blood from the medulla, and diminishing congestion.

St. Vitus' Dance (Chorea) is a disease attended by irregular spasmodic movements of voluntary muscles. It occurs chiefly among children from the beginning of the second teething to the age of fifteen, and is more frequent among girls than among boys. It may occur, though it is uncommon, in adults. A curious relation exists between chorea, acute rheumatism, and heart-disease. Rheumatism is well known as a most common cause of heart-disease, and heart-disease is frequently associated with St. Vitus' Dance. Moreover, rheumatism seems to be able to descend from parents to children, and it has been found that the children of rheumatic parents, instead of rheumatism, may manifest chorea or heart-disease, or both combined. Fright is a frequently alleged cause.

The symptoms in the fully-developed case are remarkable. The patient has no proper control of muscular movements. He cannot keep himself still. The shoulder is hitched, the arm moved about, the fingers twitching. All sorts of grimaces and contortions are produced by spasmodic movements of the muscles of the face. The movements cease during sleep. When the person attempts to do something, to grasp some object held out, or to carry anything to the mouth, the jerks become excessively marked. One failure follows another. The hand is nearing the object when it is suddenly twitched away in one direction and then in another, and the case may be so bad that he is unable, after numerous attempts, to effect the desired purpose. Efforts, specially if anyone is watching, seem only to increase the difficulty. Similarly spasmodic movements of the leg produce in walking a jerky, uncertain, jumping gait. Speaking is altered, becoming hesitating or drawling. In extreme cases chewing and swallowing are also seriously affected, and swallowing may become impossible. The case under these circumstances is easily recognized. But the disease comes on slowly, and may at first manifest itself only by slight twitchings of the muscles of expression. Children may be supposed to be grimacing on purpose, and may be punished while they are innocent. The child usually suffers in general health, becomes dull, and avoids companions, probably often because of the derision with which he is ignorantly treated. Fretfulness, timidity, restlessness, and clumsiness of gait and movement may be the ways in which the disease first shows itself.

The affection may be only one-sided; but, if it be general, one side is usually worse.

Recovery may take place speedily in the course of a few weeks, or it may be prolonged for two or three months or even for years. The cases where swallowing becomes affected, and those in which the heart is involved, are very serious.

The **treatment** consists first of all of attention to the general health. Let the bowels be put in order; let the food be light and nourishing. Fresh air, early hours, gentle exercise, mild gymnastics if possible, tepid sponging, especially with salt water, sea air also, if possible, are invaluable. The child should not be subjected to the annoyance of rude companions. At the same time it must not be petted and spoiled at home. Notice must not be taken of its peculiarity. Of medicines, tonics are best, the chief being iron and arsenic; but these should be used under the guidance of a medical man, especially arsenic, whose administration, because of certain peculiarities in its action, requires great care. If such guidance cannot be obtained, the two drugs may be given together, one drop of Fowler's solution of arsenic, and three drops dialysed iron in water *after meals* four times a day. This may be slowly increased to two drops of the arsenical solution and five of the iron. If sickness, pain in the stomach, irritation of the eyelids, and silvery-looking tongue are produced, these indicate that the dose must be reduced. The dose must be reduced slowly, *never suddenly*. For arsenic should always be administered in small doses, slowly increased, and when it is desired to stop its use the dose must be as slowly decreased till it can be gradually abandoned. *A caution is necessary.* Chorea sometimes spreads *by imitation.* Children may exhibit the spasmodic movements from watching another affected with the disease.

Tetanus (lock-jaw) is a disease of a spasmodic character in which, however, the spasms do not yield and then recur as in convulsions, forming what has been described as the **clonic** spasm (p. 180), but in which the spasms continue, causing stiffness and rigidity of the affected muscles, forming the **tonic** spasm.

Its **causes** are usually injury, sometimes simple bruises or cuts, but more frequently injuries accompanied with great destruction or crushing of parts of the body. It is, moreover, injuries obtained under circumstances that prevent their proper treatment that are most liable to occasion the disease. Tetanus is thus found among the wounded in war, whose wounds have been contaminated by earth or dirt, and without speedy opportunity of being cleansed. The real cause, however, is an organism—a bacillus—which gains access to the wound and flourishes on it, producing a poisonous substance or toxin (see Vol. I., pp. 416, 513). The organism does not spread beyond the wound; but the poison it produces is absorbed by the blood and lymph channels, but mainly by the nerves, and acts specially on the spinal cord.

This is the explanation of the fact that the wound may be thoroughly cleansed, and even healed, and yet the disease arise, because of the poison which has already passed into the circulation before the wound had been cleared of the organisms. It is more common in warm than cold climates.

Symptoms begin with stiffness and pain in muscles of the jaw and throat, giving the patient the idea that he has caught cold. With the advance of the disease, swallowing becomes difficult, even opening the mouth becomes not easy, and at length the mouth is kept firmly closed, and the jaw fixed, hence the name lock-jaw. Spasms of the muscles of the mouth draw down the corners of the mouth, showing the teeth and giving the person a grinning appearance—sardonic grin. The extension of the spasm involves the muscles of the back, belly, and limbs, so that the patient lies on his back quite rigid. The chief muscle connected with breathing—the diaphragm—may be attacked, so that the breathing is difficult and shallow. A cramp-like pain accompanies the spasm, becoming every now and again agonizing. While the stiffness of the muscles is more or less constant, it is liable to great aggravation at more or less regular intervals. During the aggravations the rigidity of the muscles may become so intense that the person is arched backwards by the excessive contraction of the muscles of the back, a condition called **opisthotonus** (Greek *opisthe*, backwards, and *teino*, I bend), or bent forwards by the muscles of the belly—**emprosthotonus** (*emprosthen*, forwards). Movement, light, sound, noise, irritation of any sort will bring on the aggravation. The laying of the warm hand on the patient's forehead may be seen to increase the spasm of the muscles of face and neck, by the increased retraction of the corners of the mouth. The paroxysms occur every fifteen or ten minutes, and last a few seconds or even minutes. During them profuse sweating breaks out. The pulse is weak and fast, the temperature is higher than usual, and often indicates the near approach of death by rapidly rising. Thirst is great. Consciousness is usually perfect even till the end, which usually occurs between the third and fifth day, from suffocation during a paroxysm, or from exhaustion. The symptoms are very like those of poisoning from nux vomica or its active principle strychnine, but in the latter case they develop more quickly, and run a more rapid course to death.

Treatment should proceed on two lines. The wound should be cleansed by such means as will destroy and remove the organisms; but this is difficult. The best agents seem to be a solution (1 in 1000) of perchloride of mercury (Vol. II., p. 448), or iodine 2 per cent dissolved with iodide of potassium in water. The second line of treatment consists of the injection of anti-tetanic serum (Vol. I., p. 514). The serum has been reduced to powder, and dusting a suspicious wound with it is said to be able to prevent the occurrence of the disease. These are obviously methods requiring surgical knowledge and skill.

Apart from these two methods of treatment, much may be done to *diminish the suffering*, little to arrest the disease. Since the smallest thing can provoke a paroxysm, the utmost quiet is necessary. The patient should lie in a darkened room. All jarring of doors, stumbling against chairs, &c., should be rigorously avoided. A quiet attendant, and only one, should wait upon him, and no visitors ought to be permitted. Early in the progress of the disease a strong dose of calomel and jalap, to produce free movement of the bowels, should be given, so that the patient need not be troubled with this afterwards. Various medicines for relieving the spasm have been tried, belladonna, nicotine (the active principle of tobacco), Indian hemp, calabar bean, woorari (the Indian arrow poison), and others. The prolonged administration of chloroform is of use. Such treatment, however, requires medical aid.

Tetany is an affection in which painful contractions of the muscles of the forearm and wrist, and sometimes of the foot, occur. It does not affect the jaw and back. It is commonest in children, associated sometimes with rickets, and in women with pregnancy and nursing.

Symptoms.—The thumb and fingers are chiefly affected, the thumb being folded across the palm, and the fingers drawn into a cone, and the hands are usually bent. The spasms also frequently affect the toes, the great toe being bent under the others, which are spasmodically curved towards the sole. In severe cases other muscles and groups of muscles are involved. These spasmodic movements are usually associated with disturbances of sensation, such as dizziness, noises in the ears, sensations of numbness. The attacks of spasm come and go, lasting some minutes or even half an hour, and separated by intervals of a day or two, or sometimes weeks. In children they sometimes keep recurring for weeks, continuing during sleep. In children, crowing (child-crowing) is often associated with the disease.

Treatment.—The muscular cramps and nerve pains are the indications of a highly irritable nervous system, which may be the result of a bad condition of general health, such as poor nourishment and bad sanitary surroundings readily produce in children. Disordered states of stomach and bowels frequently attend the disease. In such disorders, faulty digestion occurs, leading to the production of materials in stomach or bowels which, absorbed into the blood, act as nerve poisons. Thus tetany has been observed, even in the adult, to accompany cases of dilated stomach. Such conditions should always be carefully searched for.

Bromide of potassium relieves the spasm, in 5-grain doses thrice daily to children.

DISEASES AND INJURIES OF NERVES.

Inflammation of Nerves (Neuritis).—Inflammation in any part of the body may attack the nerves distributed in or passing through that part. That is to say, the nerves may simply partake of inflammation occurring in their neighbourhood, and may suffer as all the other tissues of the part do, adding enormously to the pain and general disturbance of the local inflammation. Similarly nerves may be attacked by disease just as other tissues are. Thus cancer, tubercle, syphilis may invade nerves as they do other tissues. But nerves also may be picked out, so to speak, by disease, the nerve affection being the main or the only manifestation of the disease.

Inflammation affecting nerves is a process similar to inflammation elsewhere, attended by increased blood-supply, congestion, and so on, and it may subside in time for the nerve to recover fully, or suppuration may occur, or the inflammatory material formed in and about the nerve may so compress the nerve as wholly or partially to destroy it, causing it to undergo degeneration in whole or in part.

The symptoms produced by these changes will vary according to the duty the nerve performs. If it is a nerve going to a muscle, the muscle will be weakened or paralysed for a time and will undergo wasting or atrophy. If the nerve recovers in time, all this may be recovered from; but if the nerve is destroyed wholly or partially, the muscle will be correspondingly permanently impaired. Thus there is produced a **local paralysis.** If the nerve is a large trunk, supplying a large number of muscles, then a corresponding number of muscles will be involved and a whole limb may suffer, more or less, and temporarily or permanently.

If the nerve is a sensory nerve, then the chief manifestation will be pain or some other disturbance of sensation or loss of sensation, greater or less, temporarily or permanently, according to the extent and nature of the nerve affection. Moreover, as sensory nerves not only confer sensibility on the skin, but also preside over the nutrition of the skin, the nourishment of the part of the skin supplied by the affected nerve will be impaired, and sores or sloughs will form.

If the nerve is a mixed nerve, partly motor and partly sensory, then the disturbances due to its disease will involve the muscles and the skin, so far as supplied by it.

Nerves, we have seen (p. 131), regulate blood supply, control the activity of glands, maintain the nutrition of joints, and so, according to the nerves affected, there may be manifestations of disturbed circulation, irregularities of secretion, affections of joints, and so on.

The **causes** of such conditions are too varied to permit of their detailed consideration in such a work as this. Some of them may be merely noted. Injury is, of course, a very frequent cause. The neuritis in such a case would be confined to the nerve injured. Exposure to cold is another cause. For instance, the paralysis of one side of the face due to a draught from an open window playing on one side of the face is the result of a neuritis of the nerve of the face, the seventh cranial, or the facial nerve (p. 152).

Rheumatism and gout are very common causes, or, to put it in other words, the poison circulating in the blood, which is the cause of rheumatism or gout, while it attacks the joints in some persons, may in others produce an inflammation of nerves. In such a case one nerve might be attacked at one time and another nerve at another time, or several or many nerves more or less simultaneously. One might thus have what is called a **multiple neuritis,** of gouty or rheumatic origin, in which treatment would not be directed so much to the particular nerve or nerves involved, but to the gouty or rheumatic state of body.

In the same way the nerve inflammation or neuritis might be a tubercular or a syphilitic one; and it is a common complication of diabetes. The poison of many infectious diseases shows a marked tendency to produce nerve inflammations in some people. Diphtheria is notably so, and thus is produced diphtheritic paralysis. Influenza is also notorious in this way, and doubtless some at least of the severe pains suffered in influenza attacks are due to nerve inflammation. But similar affections of nerves may occur in erysipelas, typhoid fever, and others of the infections. A very remarkable illustration of this is a disease, first described in Japan, where it is called Kakke, but also occurring in the islands of the Pacific, in the Philippines, Borneo, and the Dutch islands of the Pacific, where it is called Beriberi. It is an epidemic disease, and is an infectious multiple neuritis, in which, with fever, there is weight and weakness of the legs, some loss of power of movement and of sensation, which, in severe cases, goes on to paralysis, extending from the legs over the whole body, accompanied by severe pains. In these severe cases the patient becomes extremely helpless, emaciated, and dies of exhaustion, and it may be a very fatal disease.

Poisons introduced into the body from without may also produce inflammations of nerve. Arsenic and lead and phosphorus do this, as well as others. Alcohol is an extremely common cause, and outbreaks of multiple neuritis have been described among beer-drinkers, due to the presence of arsenic in beer, the arsenic being, quite unknown to the brewers, present in an artificial sugar used in the brewing.

The **treatment** of a condition, which might be due to any one of so many different causes, must obviously depend upon the unravelling of the cause. It will be sufficient to note here that rest, and, if it be a limb that is mainly involved, protection by enveloping in wool, and elevation on a pillow, with the application of warm poultices or fomentations, are the chief means of treatment. In painful conditions, also, the use of a mixture of antipyrin and bromide of potassium, recommended for fever on p. 512, with the addition of 1 grain citrate of caffein to each dose, will give great relief.

Neuralgia is nerve pain; and it may affect any nerve, occurring sometimes in the trunk of the nerve, but often being felt in the parts in which the affected nerve ends, even though the cause may be acting on the nerve at its origin. It is liable to produce spots painful to touch over the place where a nerve issues from an opening in a bone, or pierces some tissue, to reach the surface.

The **causes** are numerous — injury to the nerves, or irritation due to some inflammatory action. For example, neuralgia is often due to the irritation set up by a diseased tooth. General bad health is a fruitful source of neuralgia. Depressed health, poverty of blood, or altered conditions of the blood, such as are found in rheumatism and gout, and occasioned by malaria, ought at the very first to be considered in the search for the cause.

Symptoms. — The pain varies in character, being stabbing, tearing, grinding, gnawing, burning, cutting, or tingling, and so on; and it is often, indeed usually, in paroxysms or darts, being subject, even when continuous, to sudden aggravations of an unbearable sort. During these aggravations the person may be completely unmanned. He presses over the painful place with his hands, his face may flush up, and a profuse perspiration break out, and sudden twitchings of muscles may accompany the spasm of pain.

Frequently the pain recurs at certain periods of the day. It is in such cases quinine is likely to have its best effect.

The **treatment** of neuralgia consists first of all in removing, if possible, the cause, the source of irritation, in rectifying the condition of health which lays the person open to it. Treat rheumatism, gout, bloodlessness, &c., if any of these exist, in the appropriate way. Nourishing food, salt-water bathing followed by brisk friction of the skin, exercise, early hours, avoidance of fatigue overwork and anxiety, regulation of the bowels, and abstinence from stimulants and bad habits, in fact, all means that restore a good tone to the bodily system, will aid in overcoming neuralgic affections. Secondly, medicines may be given directly for the disease; chief of these is quinine, in at least 5-grain doses, and quinine, combined with iron, arsenic also *for adults* (3 drops to 5 of Fowler's liquor), or phosphorus in the form of the pill recommended for headache. *A combination of the utmost value, specially in neuralgic headache, is 5 grains of quinine, with 20 grains of salicylate of soda, given twice in the twenty-four hours.* Other treatment will be mentioned in discussing forms of neuralgia.

Tic Doloureux is neuralgia of the fifth nerve (see p. 151). It occurs on one side of the face, produced, it may be, by a diseased tooth, by inflammation in the ear passage, by exposure to cold, by dyspepsia, or other causes. It may affect the whole side of the face, or only parts of the face. When it affects only a certain region of the face, it is usually one of three parts. The fifth nerve has three divisions: one, after passing through the orbit, comes out to the surface, under the skin, near the inner end of the eyebrow, and spreads over the forehead. When this branch is affected the pain spreads from the spot over the forehead. The second branch comes to the surface just below the lower eyelid, and the pain from it spreads over the cheek and upper lip, the side of the nose, and round the under side of the eye. Neuralgia of these branches is readily accompanied by swelling of the face about the eyes, redness of the eyelids, and watering of the eyes. The third branch runs in the substance of the lower jaw, supplying the teeth, and comes out of the bone by an opening in the middle line in front.

Consequently, when the pain is occasioned by it, it is felt along the lower jaw on the one side, in the teeth and chin, and a tender point may be in front over the place of exit of the nerve. The slightest pressure of the jaw, as in chewing, will, in some cases, produce excruciating pain. Thus this branch may be irritated by a decayed tooth, and if the irritation be severe the whole branch may be involved, and the irritation may even spread backwards from it to the other branches till the whole nerve is affected.

Treatment for tic naturally consists in removing the bad tooth, the disease of the ear, &c., if such exists. Besides the treatment mentioned for neuralgia generally, the application of aconite ointment to a small part of the surface, the use of warm applications and of blisters, and the employment of a constant current of electricity over the affected nerve are all useful. Very often, if a medical man be at hand to administer it, the injection under the skin of $\frac{1}{6}$th of a grain of morphia will relieve in a few minutes.

Sciatica is neuralgia of the sciatic nerve, which passes down the back of the thigh to the knee (p. 153). It is often very acute and persistent, resisting all remedies. Any of the causes already noted, as producing inflammation of nerves and neuralgia, may operate on the sciatic nerve and occasion sciatica. In addition, it must be noted that the sciatic nerve arises in the pelvis, and passes out of it into the thigh through an opening in the bony wall of the pelvis. In the pelvis, where it arises, it may be pressed upon or irritated, for instance by accumulations in the bowel, by abscesses or growths in its neighbourhood; it may be involved in inflammations occurring in its neighbourhood; and tubercular disease of the bony notch through which it passes may extend to it. It can, therefore, be easily understood how a persistent case of sciatica may require most careful, patient, and elaborate investigation to determine its exact cause and seat of production, and how it may frequently be exceedingly difficult to get at the place where the mischief arises. While this is so, it is equally true that the most frequent cause of sciatica is a gouty or rheumatic inflammation of the sheath, which surrounds the nerve, in some part of its course.

Treatment to be satisfactory must have regard to the cause and the place where it is operating.

In the rheumatic and gouty cases full doses of some anti-rheumatic remedy like salicine, salol, aspirin, iodide of potassium, or anti-gouty remedies like lithia, carbonate of potash, thialion, piperazine, aided when necessary by morphia, will obtain relief. When the acute stage is over, massage, electricity, and treatment at sulphur spas like Harrowgate, Strathpeffer, Aix-la-Chapelle, &c., are frequently necessary to remove thickenings and adhesions in the nerve sheath, which maintain pain and cripple the patient.

Injuries of nerves are common. A wound may completely divide a nerve; a dislocated bone may so compress it as practically to destroy a portion of it; and a fractured bone may seriously tear it. If a nerve has been severed, or so injured that it is destroyed as a continuous structure, then it is evident that paralysis of sensation or motion will be produced in the part which it supplied, according as it was a motor or sensory nerve. If, however, the cut ends are brought together, they will unite, and in time sensation and motion may return. The earliest such a result could be expected is from three to four weeks. On the other hand, the nerve may be so injured that it is impossible for restoration to be accomplished. In such a case the power of movement will be lost in the muscles to which it proceeded. Further, the muscles will waste and decay, and may contract spasmodically, and so produce deformity. If the nerve has been one of sensation, then degenerative changes will be set up in the region of skin which it supplied, and the skin become blistered, or ulcerated, or covered with eruptions, while numbness will pervade the region. Severe pain and inflammation may also be produced.

The treatment of such injuries is so dependent on their character that medical aid can hardly be dispensed with. It need only be mentioned that shampooing paralysed muscles, and the use of electricity, will delay decay and its more serious results for a considerable time, while morphia injected under the skin will relieve pain.

Of course proper treatment of fractures and dislocations *from the moment of their occurrence* will do much to prevent such evils, by guarding the nerves and other structures from injury after the accident in the way described on page 79; while the accurate bringing together of the edges of a wound, and keeping them together, is as necessary for union of cut nerves as for other tissues. (See WOUNDS.)

SECTION X.

THE DIGESTIVE SYSTEM.

ITS STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

General Sketch of the Digestive System:—
- *The Alimentary Canal*—its various divisions:
- *The cavity of the abdomen*—its organs; and their relative positions; the peritoneum and mesentery:
- *Food*—the necessity for food—the kind of food required—the destination of food—the purpose of digestion.

The Digestive Apparatus:—
- *The Mouth, Teeth*—their kinds and structure, *the tongue* and *salivary glands:*
- The *pharynx* and *gullet:*
- The *stomach*—its coats and glands:
- The *small intestine*—its divisions (duodenum, jejunum, ileum), its glands and villi:
- The *large intestine:*
- The *blood-vessels of the alimentary canal*—the portal vein:
- *The liver*—its structure, blood-vessels, and bile-ducts—the gall-bladder:
- The *pancreas* or sweet-bread.

The Digestive Process
- *in the mouth*—mastication (chewing), insalivation (mixture of food with saliva), the nature and action of saliva, deglutition (swallowing),
- *in the stomach*—gastric juice, its nature and actions, artificial digestion, conditions of digestion, time required for digestion, absorption by the stomach,
- *in the small intestine*—the nature and actions of pancreatic juice, bile, and intestinal juice, absorption by the small intestine,
- *in the large intestine*—the fæces.

Hunger and Thirst. Functions of Liver.

GENERAL SKETCH.

The digestive system includes all those organs that are connected with the function of **alimentation**, the function, that is, which has to do with the preparation of food to fit it for gaining entrance into the blood, and with the separation of the nourishing from the not-nourishing portions of the food. What exactly all this includes will be most readily understood by an outline of the course taken by the food from the moment that it enters the mouth, and of the processes through which it passes till all the nourishment is obtained from it that is necessary.

The food taken into the mouth is bruised and broken down by the teeth, being rolled about in the mouth as well, and mixed with a fluid—the **saliva**—which is poured out by certain glands in the walls of the mouth and their neighbourhood—the salivary glands. Then, made up into a mass and well moistened, it is forced into the back part of the mouth, mainly by the action of the tongue, and carried by muscular movements, constituting swallowing, into the gullet, down which it passes to the stomach. Arrived in the stomach it is submitted to the action of a fluid—the **gastric juice,**—whose operation is aided by the heat of the parts and by a slow movement of the stomach walls (**peristaltic movement**), which causes it to move in more or less of a stream along the walls. After the lapse of some time, from one to three or four hours, the process in the stomach is completed, and the food has become converted into a semi-fluid mixture called **chyme**. Some of its nourishing elements without delay pass into the blood-vessels which line the walls of the stomach; the rest escapes from the stomach into the canal of the small intestine, where it meets with three other juices—the **bile** from the **liver**, the **pancreatic juice** from the **pancreas** or **sweet-bread**, and the **intestinal juice** poured out from the wall of the intestine itself—which attack the substances which have escaped the action of the gastric juice. Along the canal of the intestine the chyme is propelled, forced onward by gentle circular contractions of the walls of the canal (**peristaltic movements**); and all along its course there are being slowly abstracted from it all the nourishing elements it possesses. From the small intestine the remains of the food pass into the large intestine, along which they proceed much more slowly owing to the form of the lárge bowel. During their slow progress much of the watery material that remains is removed, and finally the waste matters, having obtained some degree of consistency, accumulate in a dilated portion at the end of the large bowel, termed the **rectum**, till they are expelled by an effort of will.

We have then to consider in detail the alimentary tract or canal extending from the mouth to the end of the rectum, the juices met with at various intervals, the glands which produce them, and the actions they exert upon the food, and the means by which the digested food is made to give up its nourishing portion to the blood.

The **alimentary canal** is the anatomical name given to the whole length of the canal or passage along which the food is carried. Its average length in the adult is about thirty feet, or about five or six times the length of the body. The mouth, with the teeth and salivary glands, is situated in the head. The gullet, whose upper wide portion, situated at the back of the mouth, is called the **pharynx**, is chiefly in the cavity of the chest, lying against the back-bone; and it passes through the muscular partition that separates the chest from the belly—the **diaphragm**—to open into the stomach. The stomach and remaining portions of the canal are placed in the cavity of the belly, which conceals them, and which is therefore called the **abdomen** (Latin, *abdere*, to conceal).

The appearance and position of the different parts of the alimentary canal will be better understood by referring to the accompanying wood-cut and description (fig. 99).

The opening out of the rectum (*n*) on the surface of the body is called the **anus**. At this place there is a double narrowing, caused by circular bands of muscular fibre round the canal. These bands form what is called the sphincter of the anus, and prevent the accumulated matters in the rectum passing out until the sphincter is relaxed by an effort of will.

Observe that the bend at the sigmoid flexure (*m*) helps to relieve the rectum and sphincter of the anus of the pressure of the matter contained in the descending part of the large bowel. Without that relief there might be difficulty in maintaining the closure of the sphincter.

The **cavity of the abdomen** has been spoken of. It is formed of muscular walls which, directly or indirectly, are supported by the back-bone behind and by the ribs above and the haunch-bones below. In the middle of the back wall of the cavity is the back-bone, but it is covered over, and its irregularities and hardnesses masked by muscle and other soft tissues. Now it must not be supposed from the diagram (Fig. 99) that the intestines lie in a loose heap in this cavity. Lining the cavity, just as, to use a very rough figure, a paper lines the walls of a room—lining the walls of the cavity is a delicate fibrous membrane called the **peritoneum**. When the peritoneum, in its course of lining the walls, comes in contact with the large bowel it passes over it, just as the paper of a room would pass over, say, a gas-pipe which ran along the surface of a wall, and in passing over the large bowel it binds it down to the wall of the cavity. The small bowel is, however, not lying against the wall of the cavity as is the large one; it is out towards the centre of the space. In order to reach it, therefore, the peritoneum from its course over the back wall passes out to reach the small bowel, passes round it so as completely to envelop it, and then passes back to the wall again to continue its course. Thus there is a double fold formed by the membrane as it passes out and as it passes back, and this double fold suspends the small bowel from

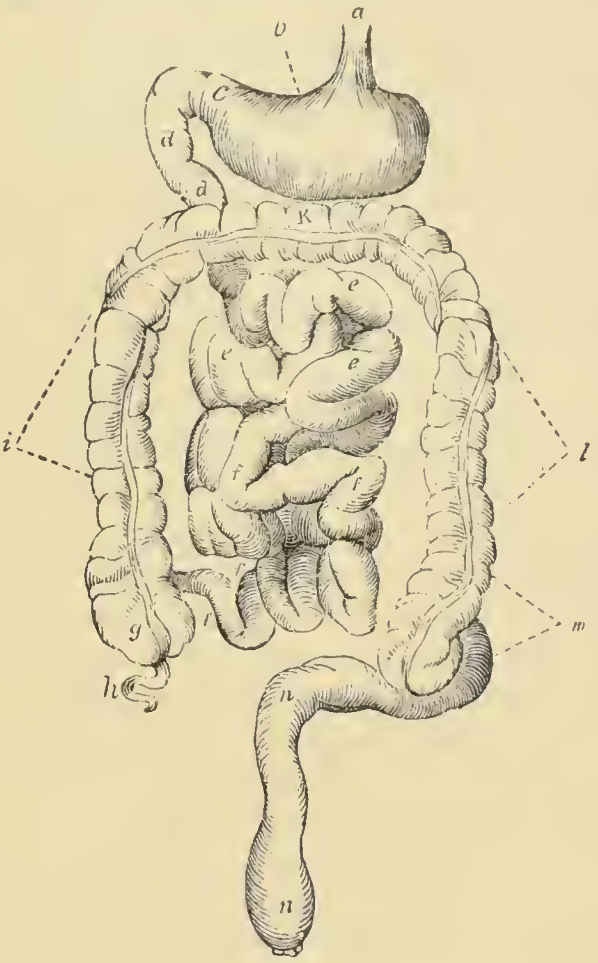


Fig. 99.—the Alimentary Canal.

a, The gullet, or œsophagus, which is continued from the back part of the mouth to
b, The stomach.
c, The pylorus, the small end of the stomach where it opens into the first part of the small intestine. At the pylorus is a thickened portion of the stomach wall, which acts as a valve to prevent the food leaving the stomach till the proper time.
d d, The duodenum or commencement of the small intestine.
e e e, The second part of the small intestine, called the jejunum.
f f f f, The third and terminal portion of the small intestine, termed the ileum (from Gr. *eilō*, to roll). This must not be confounded with the part of the haunch-bone, called the ilium (p. 63).
g, The cæcum. This is the commencement of the large intestine, and between it and the ileum there exists a valve which prevents the return of any of the contents of the large intestines back into the small. This is called the ileo-cæcal valve.
h, A round worm-like process of the cæcum, which is termed the vermiform process or appendix.
i, The first portion of the large intestine, called the ascending colon.
K, The transverse colon.
l, The descending colon.
m, A part of the large intestine which is curved on itself, somewhat in the form of the letter S, and termed the sigmoid flexure of the colon.
n, The termination of the large intestine and alimentary canal, named the rectum.

the back wall of the cavity. It is called the **mesentery**. Besides the stomach and bowels, the abdomen contains other organs, the **liver**, **spleen** (melt), **pancreas** (sweet-bread), **kidneys**, and low down in the pelvis the **bladder** and **generative organs**. The positions of these other organs will be referred to immediately, and will be more fully stated when each comes to be discussed. The general position, which most of the organs named occupy, can be roughly made out from the outside. Take the succeeding figure (100), and study it in relation to Fig. 99. It represents the front wall of the belly as mapped out into regions by the lines shown on the figure. The regions are marked off by drawing two cross lines, one connecting the lower edge of the ribs on each side, and the other by connecting the highest point of the haunch-bone on each side. The two upright lines are drawn straight upwards from the middle point of the groin on each side. There are thus marked off nine regions, each one being called by a special name, the advantage of them consisting in the list, which anatomists are able to draw up for the guidance of physicians and surgeons, of the different organs which are found to lie beneath each region.

The first region is called **epigastric** (Greek, *epi*, upon, and *gastēr*, the stomach), because it is over the stomach; the second, immediately below it, is **umbilical**, because it incloses the umbilicus or navel, and the third **hypogastric** (*hupo*, under, and *gastēr*), because it is below the stomach. These are the middle divisions. On the left side, the fifth division is left **hypochondriac** (Greek, *hupo*, under, and *chondros*), because it is the region under the ribs. Below it is the seventh division—the **lumbar** region, and next is the ninth—the **iliac** region, because the region of the ilium or flank-bone (Latin, *ilia*, the flank), the name for the chief portion of the haunch-bone (p. 63). Similar names apply to similar regions on the right side, right being substituted for left. By referring to page 63 it will be seen that these three lower divisions, namely, the 3rd, 8th, and 9th, are ranged round the upper edge of the pelvic bones, and that beneath them is the cavity of the pelvis—the lower portion of the belly—which has no region marked externally corresponding to it. As already noted, in this lower cavity lie the genito-urinary organs.

These points being understood, by consulting the following list it will be seen how one could with some ease determine the position of any particular organ from the outside. Or, again, suppose a person to be suffering from pain or swelling at a limited part of the belly, by referring to the list some idea would be gained of the organ or portion of organ that was probably affected.

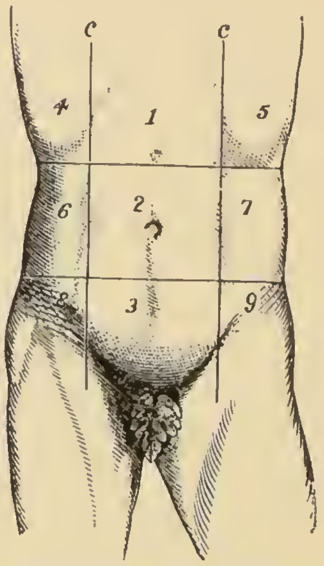


Fig. 100.—The Regions of the Belly.

1. *Epigastric Region* —The right part of the stomach, the pancreas or sweet-bread, and part of the liver.
2. *Umbilical Region.*—Transverse colon, part of duodenum, with some convolutions of jejunum and ileum.
3. *Hypogastric Region.*—Convolutions of lower part of small intestine, the bladder in children and in adults if distended, and the womb in females when enlarged.
4. *Right Hypochondriac Region.*—Right lobe of liver and gall-bladder, part of the duodenum and of ascending colon, upper part of right kidney.
5. *Left Hypochondriac Region.*—Large end of stomach, spleen, narrow part of pancreas or sweet-bread, part of colon, upper part of left kidney.
6. *Right Lumbar Region.*—Ascending colon, right kidney, and part of small intestine.
7. *Left Lumbar Region.*—Descending colon, left kidney, and part of small intestine.
8. *Right Iliac Region.*—The cæcum or commencement of large intestine, and termination of the small intestine.
9. *Left Iliac Region.*—Sigmoid flexure of colon.

The rectum lies in the pelvis.

TOPOGRAPHY OF ABDOMINAL ORGANS.

(Plates XII., XIII., XIV.)

To make still clearer the position of the various organs in the cavity of the belly, a series of plates has been prepared. Each plate represents the situation of one or more organs, the others being at the moment neglected. For instance, Plate XII. represents the kind of drawing that might be produced if a man were to ask an anatomist to trace in chalk on his skin an outline showing the whereabouts of the stomach and large bowel. These plates are self-explanatory, but the interested reader would derive some advantage by referring at this point to Plate XII. and its description, as well as to Plates XIII. and XIV.

FOOD.

It is not intended at this place to discuss all that is included under the general heading Food. That is delayed to the part of the work devoted to Hygiene, where information will be given about the various kinds of food-stuffs of a more detailed character. Only what is necessary for the understanding of the process and purpose of digestion will be considered here.

The Necessity for Food.—A healthy man, doing his ordinary daily work, may be compared to a steam-engine in thorough working order. As an engine uses up fuel and water for the purpose of obtaining from them the energy necessary to perform its work, so a man consumes certain substances in order to obtain from them the energy necessary for his life and activity, and all these substances he obtains from the blood. In short, a man by the daily work of his body, whether that work implies merely the movements of heart and chest, the maintenance of the heat of the body, and so on, just what is necessary for life, or implies besides manual or mental labour—a man by the daily work of his life consumes certain parts of his body. Waste goes on within his body. Suppose the waste were allowed to continue, no effort being made to supply the place of what had been consumed, the man would continue to live and work at the expense of his own body. This could not long be endured without danger. The waste must, therefore, be repaired, and food is the means by which this is accomplished. Let us see now what is the nature of the waste. An ordinarily healthy man passes out of his bowels daily, on an average, 5½ oz. of material, a large proportion of which—not less than 75 per cent indeed—may be considered water, by the kidneys, 56 oz., 96 per cent of which is water, by the skin, in the shape of sweat, a variable quantity, 23 oz. or thereby, of which 99 per cent is water, and by the lungs 34 oz., of which 10 oz. are water and the remainder carbonic acid gas. Therefore, setting aside for the moment the 25 per cent of the solid matter removed from the bowels, which will be mainly indigestible or undigested remains of the food—setting that aside, the main bulk of what a man passes out of his body daily consists of water, carbonic acid gas, and certain solid matters contained in solution in the urine, sweat, &c. Now, the chief of these solid matters is a substance found in the urine called urea. Urea is made up of the four elements carbon, hydrogen, oxygen, and nitrogen. Water contains only two elements, hydrogen and oxygen, and carbonic acid also only two, carbon and oxygen. It appears, therefore, that what a man casts out of his body daily consists essentially of four elements, carbon, hydrogen, oxygen, and nitrogen. Now these four elements cast out of the body in the shape mainly of water, carbonic acid gas, and urea, represent the consumption that has been going on in the body to produce the energy necessary for the man's life, even as the smoke, ashes, and steam represent the consumption of fuel and water going on in the steam-engine. It is, consequently, evident that if one could restore to the body daily a quantity of those four elements similar to that cast out one would be able to make up for the waste that had been produced. The purpose of food, then, is to restore an amount of the four elements equal to that used up, to repair the waste.

The kind of food required.—One would imagine that if a meal were set down to a man consisting of so many ounces of carbon (charcoal), so many ounces of hydrogen gas, so many of nitrogen gas, and so many of oxygen, he would have all that was required to maintain his strength. But man, in common with other animals, is unable to take the elements, the raw elements, in this way, and make use of them. He needs to have the elements put into combinations that will suit his peculiar organization. Plants are able to take the elements up, however, and transform them into the living substance of their own bodies. Plants combine them, that is to say, for the benefit of man and the rest of the animal kingdom; and then men and animals make use of plants for food—corn, wheat, barley, potatoes, and so on,—and so obtain the elements in a combined state which they could not make use of in the simple state. So that the question comes to be, is there a substance containing the four elements named which man can use as a food to repair the waste of his tissues? There is a class of substances, called **Proteids**, which contain all four elements, carbon, hydrogen, oxygen, nitrogen. They are also called **albuminous** substances, because a type of the class is **albumin**—white of egg. Belonging to the same class is a substance called **gelatin**, obtained by boiling tendons and connective tissues, another called **chondrin**, yielded by boiling cartilage (gristle). Another of the class is found in flour, called **gluten**; and in peas or beans is still another, **legumin**. The curd of milk, from which cheese is made, consists mainly of an albuminous body—**casein**, and from flesh is found another of the class, namely, **myosin**. So that all four elements one could obtain from a quantity of white of egg, curd of milk, or meat. So one might well ask the question, since an albuminous body contains all the required elements, can a man not live on, for example, white of egg alone, or lean meat alone, or a diet of beans or peas alone? Well, an American physician, Dr. Hammond, in 1857 tried some experiments on himself, and limited himself to $1\frac{1}{2}$ lb. of albumin daily, with 4 lbs. of distilled water. On the fourth day he began to experience loss of appetite, headache, and weakness. His disgust at the perpetual sameness and tastelessness of the diet became almost unbearable, and on the ninth day, after severe diarrhœa, he had to give it up. Now, this is not to be wondered at, considering the tastelessness of the diet; but albumin might be made to form the chief portion of the diet, but might be given in a much more palatable form, and might be varied—white of egg one day, lean meat another. Still the attempt to live on an albuminous diet alone would be very difficult to accomplish, for a reason that will now be given. The total quantity of nitrogen cast out of the body daily by a man under ordinary circumstances is 300 grains, of carbon about 5000 grains. The quantity of hydrogen and oxygen cast out are replaced by oxygen obtained from the air he breathes, of which he will take into his body by his lungs about 2 lbs. weight daily, and by water, which contains oxygen united with hydrogen, of which 60 to 70 oz. per day are sufficient. Thus, supposing a man to have pure air to breathe and water to drink, he requires 300 grains nitrogen and 5000 grains carbon; that is, 15 grains of carbon for every 1 of nitrogen. In albumin, however, the proportion of nitrogen to carbon is 1 to $3\frac{1}{2}$ instead of 1 to 15, which is as much as to say that a man who sought to live on albumin would get in his food a proportion of 1050 grains (instead of 5000) of carbon for every 300 of nitrogen. In other words, in order to secure his 5000 grains of carbon he would require to take a quantity of albumin that would yield him that amount. But this quantity yields also 1428 grains of nitrogen, which are 1128 more than he requires. So that to live on albumin alone he needs a quantity that gives him far too much nitrogen, for which he has no use, and which casts labour on his body to get rid of the excess. To take an example, one would require to eat 4 to 5 lbs. of lean meat to get 5000 grains of carbon, while 1 lb. will yield the required nitrogen. To eat 5 lbs. of meat would mean immense unnecessary labour cast on the digestive organs. Only an albuminous body, however, will yield nitrogen in a condition to be made use of by man, and we are, therefore, face to face with the next problem: is there any other class of foods which could be mixed with the albuminous so as to get the required carbon and nitrogen in the most economic way? The class of food-stuffs to which fat belongs contains carbon, hydrogen, and oxygen, without any nitrogen, and a class called amyloid or carbohydrates, to which sugar, starch, and gum belong, contains the same three elements without any nitrogen. We thus see that by taking a quantity of lean meat or white of egg just sufficient to supply 300 grains of nitrogen the addition to it of a certain quantity of sugar, starch, or fat will provide the necessary carbon without increasing the nitrogen. Or, to take a better example, bread contains carbon in the shape of sugar and starchy matters, and albumin in the shape of the gluten of the flour. It has all the requisite elements, therefore, but in it the quantity of nitrogen is small in comparison to the quantity of carbon. Enough carbon could be obtained out of 2 lbs. of bread, but this quantity would yield only half the amount of nitrogen, so that 4 lbs. of bread would be required to yield a sufficient amount of nitrogen, and that would contain double the carbon necessary. Thus bread has the carbon in abundance, but is deficient in the nitrogen, and lean meat has the nitrogen in abundance but is deficient in the carbon. Unite the two, and you have as a result that 2 lbs. of bread yield very nearly the required amount of carbon and half the required nitrogen, and $\frac{3}{4}$ lb. of lean meat yield the other half of the required nitrogen and a small quantity of carbon, sufficient to swell that obtained from the bread to the full amount required. A combination, then, of two different kinds of food-stuffs, in proper proportions, yields the required substances for repairing the waste of the body, while it throws the least possible amount of work on the body for their digestion. In this consists the economy of a mixed diet. One of the most admirably proportioned of human diets is milk, which contains albumin in the form of curd (casein), that is the nitrogen, and the carbon in the form of fat (the cream) and sugar (the sugar of milk). These are dissolved in water, all in due proportion, and thus we have a type of a food fitted not only by its ingredients for the nourishment of the body, but by its form for easy and rapid digestion and passing into the blood.

It is now necessary to remark that there are cast out of the body, besides substances containing the four elements mentioned, other substances belonging to the mineral kingdom—saline bodies, chief of which are salts of soda and potassium, and particularly chloride of sodium (common salt). These must also be replaced. Bread invariably contains such salts, so also does milk, meat as well.

To sum up, then, we see that to replace waste there must be introduced daily into the body a certain quantity of water, a certain quantity of solid food containing albumin, and fat, or starch, or sugar, and a small proportion of saline material, and a certain quantity of oxygen gas taken in by the lungs. The quantity of water has already been stated as between 60 and 70 oz. daily, and the quantity of solid food ought to be 28 oz. This is the least quantity that is consistent with maintenance of vigour for an ordinarily healthy man doing an average amount of work.

[For information about the nourishing qualities of various sorts of food, and accessory food factors or vitamines, refer to Vol. II., pp. 100, 141.]

The destination of food.—The purpose of food, it has been seen, is to repair the waste going on continually in the body. The waste occurs in no one part in particular, but in all the tissues of the body. The contraction of a muscle necessary to move a limb means the using up of some portion at least of the fibres of muscle, the waste, that is, of some of the elements which go to make up the contracting muscle. The beating of the heart means the same thing, the perpetual consumption of some of the particles which go to make up the heart's substance. The activity of the liver means the constant breaking down of the small cells of which the liver is composed. Thinking, feeling, willing, imagining, in the same way are all attended by the waste of nervous tissue. So it is with every organ and tissue of the body. For a more detailed discussion of this fact read the "Story of a Muscle in Action", p. 3.

Every one of these tissues comes into direct contact with the blood. Every organ has its blood supply conveyed to it by vessels large or small according to the size and activity of the organ. The blood-vessel has no sooner entered into the organ or tissue than it breaks up into a number of branches, which in turn send off countless tiny streams that flow through the tissue, pervading it in every direction. As a result the ultimate cells or fibres which form the tissue are constantly bathed by the streams that continually flow past them. The cells and fibres are continually wasting, and the stream of blood as continually brings to them the means of repair. It offers to them the raw material needed for their continued industry; and they are able to select from the passing current whatever they require to repair their waste and to provide for their renewed activity. At the same time, as the current goes past it is a convenient channel for the removal of the products of waste, that must not be allowed to remain in the tissues. The waste, then, occurs in the tissues, the means of its repair are obtained from the blood. In the end it is the blood that is impoverished. From it the drain of nourishment takes place. So long as it is of proper strength and in proper quantity the renewal for the wasted tissues is provided. So that due provision is made for the nourishment of the tissues if a proper condition of the blood is maintained. Thus the food we take is first of all directed to renewing the blood and maintaining its efficiency. While, then, the purpose of the food is for the repair of waste, its immediate destination is the blood. How does it get there? is naturally the question. It must pass into the blood-vessels out of the cavity of the stomach and the canal of the intestine; but how? There are no visible openings communicating with this canal on the one hand and the blood stream on the other. There is no vessel or channel which acts as a medium of communication between the two.

In 1837 a Frenchman named Dutrochet described some remarkable experiments made by him. He found that if he took a tube open at both ends, one end being of a bulb shape, and if he closed the bulb-shaped end with a piece of animal membrane, a piece of bladder, for instance, then filled the bulb and tube with a strong solution of salt, and dipped it into a glass jar containing water, two currents were set up through the membrane. A current of water passed from outside through the membrane into the salt solution, so increasing the quantity of liquid on that side that it rose in the tube. At the same time salt in solution passed through the membrane into the water outside and could be detected there very soon. Anyone can repeat this experiment for himself, and, provided the solution be strong enough, and the bulb be kept dipping in the water outside, the liquid will continue to rise in the tube of the bulb for days, so that many feet of tubing have to be added, end to end. At the close of the experiment a very large quantity of the salt will be found to have passed into the water outside. The process by which the water passes through the membrane into the bulb is called **endosmosis**. Since the days of Dutrochet many experiments have been made of a similar kind. Sugar and salts of all kinds are capable of producing the currents and of passing in solution through animal membranes. Instead of the water, a solution of salt may be placed in the jar outside, and, provided the strength of the outer and inner solutions is different, the same interchange will go on through the membrane, or solutions of two different substances may be used with a like result. The general result may be put in this way: whenever there are two different solutions separated only by an animal membrane an interchange will take place between them through the membrane.

Now let this be applied. In the stomach and intestinal canal there is a quantity of liquid food, to a great extent a liquid containing many substances in solution. In the walls of the stomach and bowels there is flowing a stream of blood, another liquid containing many substances in solution. These two liquids are separated from one another by the extremely thin walls of the channels along which the blood flows, and by a thin portion of the wall of the intestinal canal, in short, by an animal membrane. The liquid in the alimentary canal contains a much larger quantity of dissolved substances than the blood. The inevitable result will be that an interchange will take place between the blood and the contents of the stomach and bowels, resulting in the passing through the wall of the intestinal canal into the blood of the dissolved substances of the food. A continuation of the experiments of Dutrochet, especially those made by Graham, the late Master of the Mint, throws further light on this subject.

The purpose of digestion.—The experiments show that while substances like sugar and salt readily pass through the animal membrane, other substances, like albumin, starch, gum, and fat pass through with great difficulty, indeed hardly at all. Suppose into the bulb closed by the animal membrane a solution of salt, starch, sugar, and white of egg be placed, and then the bulb dipped into the jar of water. After some time, if the water outside be in sufficient quantity, all the salt and sugar will be found to have passed out of the bulb, but none of the starch or white of egg, which are still retained. Accordingly, when one takes a meal of bread and meat the contents of the stomach will consist of a liquid containing albumin obtained both from the meat and bread, fat from the meat, starch and sugar from the bread, and salts of various kinds from both. The sugar and salt will readily pass through the animal membrane of the intestinal walls into the blood, but the albumin, fat, and starch never will. Yet as it is absolutely necessary that they also gain entrance to the blood, it is obvious that they must undergo some change that will confer on them the power of passing through animal membranes. Now starch can be converted into sugar, and sugar can pass through membranes, and albumin can be converted into a substance called peptone, which also can pass through membranes. The power of converting starch into sugar is possessed by the saliva from the salivary glands, and by the juice poured into the bowel from the pancreas (sweet-bread), and the power of converting albumin into peptone is possessed by the gastric juice poured out from glands in the walls of the stomach and by the juice from the pancreas as well. Fat, again, cannot pass through a membrane, but fat and soda make a soap. Now the bile is an alkaline fluid, it contains a large quantity of soda salts. It mixes with the fat in the small intestine, and so saponifies it—makes it soap-like—that it becomes possible for it also to pass through a membrane. The story of digestion is practically this, then, that the food we take must get into the blood; but to get there it must pass through the walls of the stomach or bowel interposed between it and the blood. To pass through these walls it must first be made into a solution, so the food is broken down by the teeth and mixed with fluids poured into it from various glands. With no further change the salts, sugar, and similar substances can pass at once through the animal membrane into the blood, but the albumin, fat, and starch cannot: they are, therefore, acted on by the juices till they are converted into substances that can pass. The whole purpose of digestion is, therefore, to make the food into a condition that will enable its nourishing elements, albumin, fat, starch, sugar, and salts, to pass into the current of blood circulating in the walls of the stomach and intestines.

Secretions.—The juices that the food is mixed with in the alimentary canal which transform it into absorbable material, are produced by glands, salivary, gastric, to be described, and are called secretions.

THE DIGESTIVE APPARATUS.

The Mouth is a cavity formed by the lips in front, cheeks at the side, tongue below, and palate above. The roof of the mouth derives its bony part from the upper jaw-bone on each side and the palate bones behind (see p. 60); the bone is covered by the mucous membrane (*c*, Fig. 101) of the mouth. Reference to Fig. 101 will show that the bone (*a*) forms only the front portion of the palate—the hard palate, as it is called,—for the bone stops short at *b*, and the continuation is effected by mucous membrane and muscular substance as the soft palate, of which the uvula (*u*) is a part. The hard and soft palates form not only the roof of the mouth but also the floor of the cavity of the nose (*n*, Fig. 101), so that they partition off the nose from the mouth. Now sometimes this partition is not properly developed, and a cleft exists in the soft palate. The cleft may extend forwards some distance and may involve the hard palate, so that the partition is incomplete and an opening more or less wide permits of an unusual means of communication between the mouth and nose. The result is a very serious defect of speech, the air being sent up into the nose. The mouth is continued behind into the throat, the separation between mouth and throat being marked by a narrowing, called the **isthmus of the fauces.** This constriction is formed of fleshy pillars—the pillars of the *fauces*—which arch up from the sides to form the **soft palate or velum**; and from their meeting-place in the middle of the arch there hangs down a portion, termed the **uvula** (*u*). At each side, where the pillars begin to arch up, is an almond-shaped body—the **tonsil,** which ought not to be prominent at all, but which swells and projects towards the middle line in inflamed throat, threatening often to block the way from the mouth into the throat. The tonsil is seen in the figure partly covered by the uvula. The whole mouth is lined with *mucous membrane.* This membrane is really in its essence the same as the skin which lines all the external parts of the body. On referring to the section on the SKIN it will be seen to be of two layers—a deep one of a fibrous structure, rich in blood-vessels and nerves, and one on the surface of this, consisting of cells only, with no vessels or nerves. In mucous membrane the same two layers are found, only they are more delicate and soft. At all the openings of the body the skin becomes modified into mucous membrane, which takes its place and lines all the cavities and channels of the body which communicate with the exterior. The mucous membrane of the mouth is, therefore, continuous with that of the throat, gullet, stomach, and bowels. It is beset with little glands which pour out a fluid to moisten the mouth. A view of the throat, tonsils, uvula, &c., in colour, will be found in Plate XV.

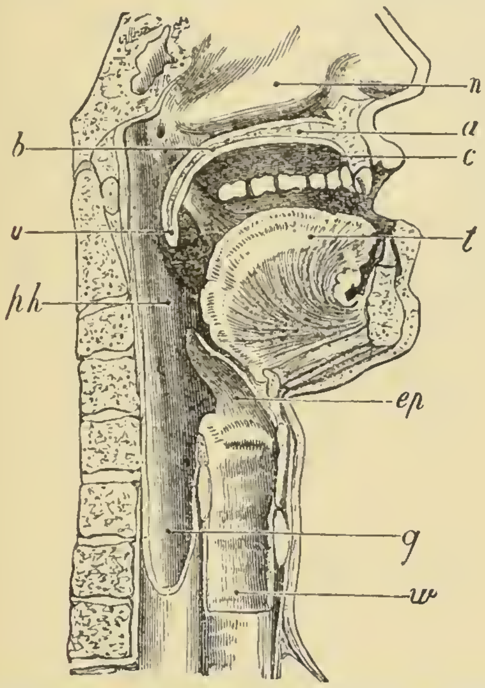


Fig. 101.—Section showing Mouth and Nasal Cavities, Gullet, Wind-pipe, &c.

t, tongue; *ph*, pharynx; *ep*, epiglottis; *g*, gullet; *w*, windpipe. For other references see text.

The Teeth are embedded in sockets in the upper and lower jaw-bones. Each tooth consists of a **crown**, the visible part, and one or more **fangs** buried in the socket. The teeth are thirty-two in all, sixteen in the upper, and the same number in the lower jaw. They differ in form from one another, and have different names according to their use. Thus the four central teeth of each jaw have chisel-shaped crowns with sharp cutting edges, and are called, on this account, **incisors**; they have but a single fang. On each side of these central four is one tooth with pointed extremity, the tooth developed in dogs and other animals for holding and tearing—the **canine** tooth (Latin, *canis*, a dog). The upper two are also called **eye-teeth.** Behind the canine teeth there follow on each side two **bicuspid** teeth, teeth with two cusps or points instead of one, and having often double fangs; and succeeding them are the **molars** or grinders, three on each side, broad teeth with four or five points on each, and with two or three fangs.

The following table shows the teeth in their order:—

	Mo.	Bi.	Ca.	In.	In.	Ca.	Bi.	Mo.	
Upper jaw,	3	2	1	2	2	1	2	3 = 16	= 32.
Lower jaw,	3	2	1	2	2	1	2	3 = 16	

The upright line indicates the middle line of the jaw, and shows that on each side of each jaw there are eight teeth. These are the permanent set, which succeeds the **milk-teeth**. At about the sixth year of a child's life the milk teeth begin to fall away and give place to the permanent teeth, which appear in the following order:—

Molar, first	6 years.
Incisors	7 to 8 ,,
Bicuspids	9 to 10 ,,
Canines	11 to 12 ,,
Molars, second	12 to 13 ,,
,, third	17 to 25 ,,

The first of the permanent set to appear is thus the first grinding tooth; and it appears above the gum behind the farthest back of the milk-teeth. These first molar teeth of children decay very fast, and if they are extracted early, say at the age of 9 or 10, before the second molar has appeared, the jaw will become smaller than it ought to be and contracted. Parents should always do what they can to preserve this tooth till the second molar has appeared above the jaw. If, therefore, it is much decayed early, it should be cleaned and filled rather than extracted. When the second molar appears, or is about to appear, the first may then be removed, for by that time the jaw will have grown, and the second molar with, in time, the wisdom tooth will gradually fill the space. The last to appear are the last grinding teeth, which, owing to their lateness of arrival above the gums, have been called the **wisdom teeth**. In some people they never appear above the gum at all.

Structure of Teeth.—Fig. 102 represents the appearance on a cut being carried straight down through a tooth in its socket. In the very centre of the tooth is a cavity—the pulp cavity (*f*)—which is filled up with the **dental pulp**, a soft substance containing a rich supply of blood-vessels and nerves. The vessels and nerves enter by a small opening at the point of the fang. In teeth with two or more fangs the cavity is prolonged in the shape of a fine canal down each fang, to a little opening at the point of each. Surrounding the cavity on all sides is the substance that forms the main part of the tooth—the **dentine** (*b*). It consists of fine branching tubes embedded in a hard substance. The tubes contain substance continuous with the pulp of the tooth cavity. Dentine is very hard but not brittle, consisting mostly of phosphate and carbonate of lime. Ivory is the dentine of the elephant's tusk. Outside the dentine of the fang is a substance closely resembling bone, and called **crusta petrosa** or **cement** (*c*). In fact it is true bone, but wants the Haversian canals (see p. 58). The fang is fixed in its bony socket (*e*) by means of a dense fibrous membrane (*d*) which surrounds the cement as the periosteum does bone. The dentine of the crown of the tooth is not covered by cement but by the **enamel** (*a*), which consists of closely set prisms of a densely hard substance, composed mainly of phosphate of lime and other earthy salts and only 3½ per cent of animal matter. In young teeth the surface of the enamel is covered by a delicate membrane, which answers to the popular term "the skin of the teeth". It is worn off in adult teeth.

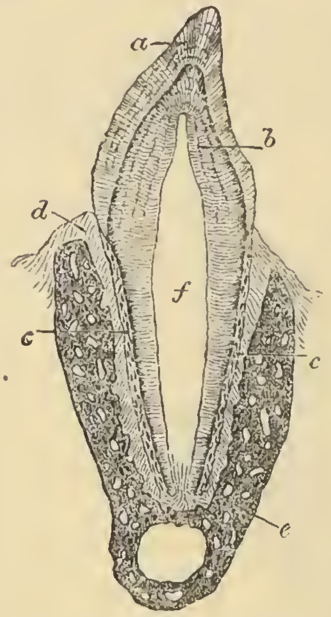


Fig. 102.—Structure of Tooth.

The Tongue (*t*, Fig. 101) is a muscular organ, and is covered by the same membrane that lines the rest of the mouth. On the under surface the membrane forms a fold in the middle line, passing between the tongue and the front of the lower jaw. This fold is sometimes continuous to the tip of the tongue, binding it down and interfering with speech, and in infants with sucking. The upper surface is covered with little projections—the papillæ of the tongue, which are connected with taste, and will be considered in the section on Taste.

The Salivary Glands are three in number on each side of the mouth. Their position is shown in Fig. 103. The **parotid gland** is situated on the side of the face in front of the ear; the **submaxillary** is placed below and to the inner side of the lower jaw, in front of the angle of the jaw; and the **sublingual** is on the floor of the mouth between the tongue and gums. The two sublingual glands are thus near to one another, one on each side of the fold beneath the tongue. All these glands

PLATE XII

THE TOPOGRAPHY OF THE STOMACH AND BOWELS

FRONT VIEW

This plate represents the situation of certain internal organs relatively to the surface.

Surface landmarks. Certain marks on the surface may be taken as landmarks, for example, the right and left **nipple**, and the **umbilicus** or **navel** (**U.**).

Bony landmarks. Any person could, with coloured chalk, mark out the position of the collar-bone, breast-bone, and ribs on the chest of another person, simply by running a finger of the left hand along these bones, one after the other. With the finger of the left hand as a guide, the other hand, following with the chalk, marks them. Thus such an outline could be produced as is shown on the plate, where

Cl. marks the outline of the **left collar-bone**, and the figures 1, 2, 3, up to 11, are on the **ribs**.

These figures are placed on the ribs near the junction of the bony with the gristly part. The gristly part connects the bony rib with the breast-bone, **St.** (see p. 61). The pointed end of the breast-bone (En.) is an excellent landmark. Some persons are so thin that one would not need a guiding finger in front of the chalk, the outlines of the bones so stand out.

By means of those surface and bony landmarks one might outline on the skin, more or less accurately, the position any organ occupied in the interior. This would be an immense aid in determining, in the case of any pain, swelling, or wound, the organ or organs possibly involved.

Such an outline gives no indication of the depth inside the body at which the outlined organ is lying. All of the organs are nearer the surface at one place and deeper at another. To attempt to represent this would complicate these plates unduly, though in one or two plates it has been necessary to indicate by broken lines that one organ lies behind part of another.

The outline in red indicates the position of the **heart and great vessels of the chest.**

The outline in blue indicates the area occupied by **lungs.**

The broken line in black indicates the position of the diaphragm, the transverse partition between chest and belly (p. 345).

The outline in yellow indicates the position of **gullet, stomach, and large bowel** with **vermiform appendix.**

It is this outline in yellow the reader is specially asked to follow on this plate.

It indicates that the gullet runs a straight course in the middle line of the neck, that at the lower part of the neck it passes to the left side of the middle line, that in this position it runs through the chest till, at the level of the diaphragm, it curves quickly to the left to open into the stomach behind the junction of the gristly part of the 7th rib with the breast-bone, but to the left, as a matter of fact 1 inch from the breast-bone. This is the **cardiac end of the stomach** (**Card.**).

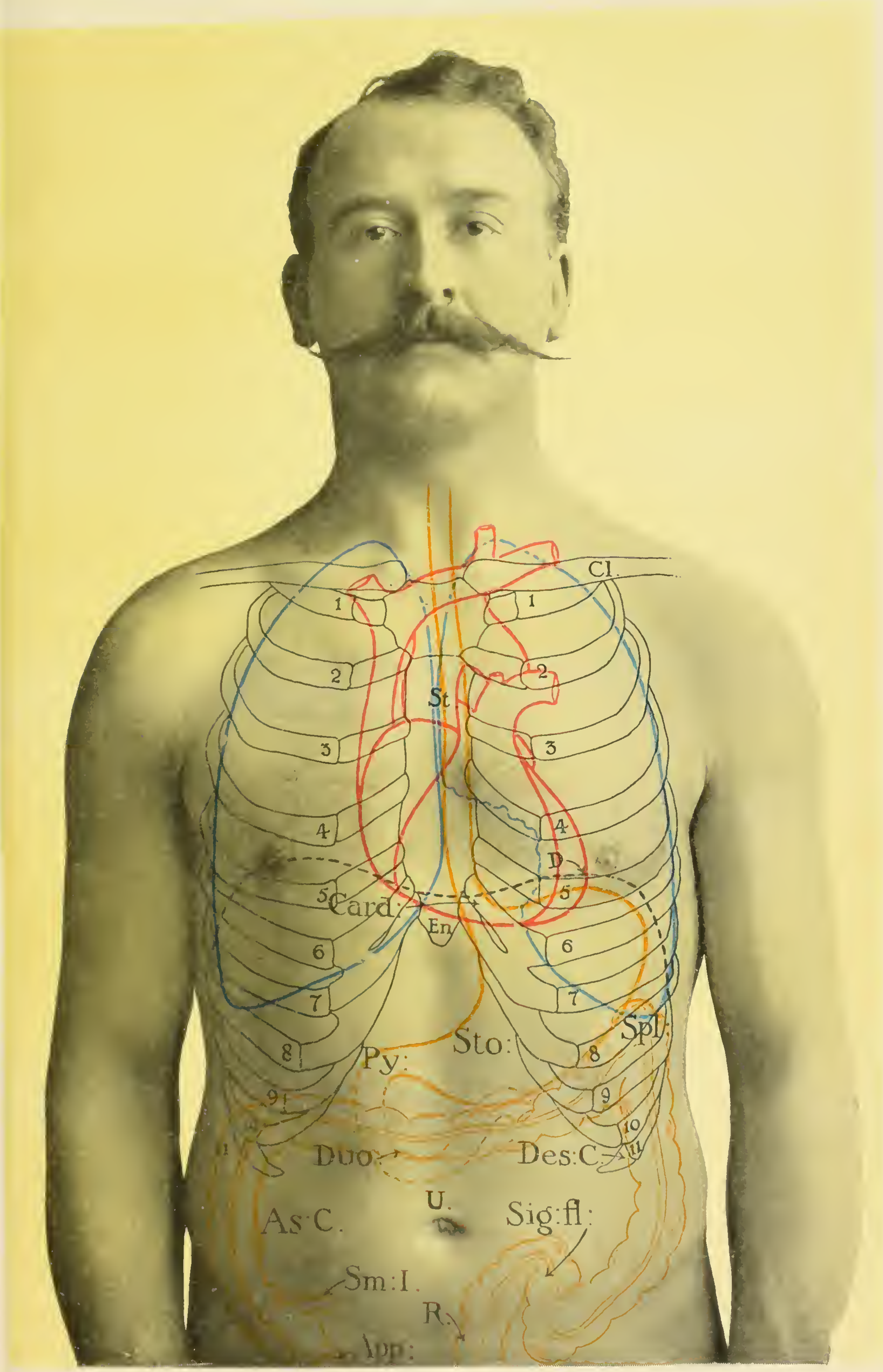
This yellow outline shows also how the stomach lies in a large curve sweeping upwards and to the left, the highest part of that curve reaching the level of the 5th rib in the left nipple line, passing downwards and slightly outwards from that point, and then sweeping inwards, the lowest point of the curve being at the middle line, and on a level with a line connecting the space between the 9th and 10th ribs of each side. From this point the great curve turns quickly upwards to meet the smaller curvature. These two curves approach one another at the place where the stomach passes into the small bowel. This exit gate of the stomach is called **pylorus** (**Py.**), and lies just to the right of the middle line and in line with the bony end of the 8th rib.

The yellow outline continues to show the first part of the small bowel, called **duodenum** (**Duo.**); it describes an imperfect circle curving upwards, backwards and to the right, then downwards, then to the left, which brings it again close up to the stomach and slightly behind. Here, where it abruptly turns down again to be continued in the coils of the small bowel, it is represented as cut off. These coils are disposed in the region about **U.**, are not outlined, and end in the right groin, where the small bowel passes into the large. This junction is shown at **Sm. I.**

The yellow outline indicates how the large bowel begins in a blind extremity in the right groin, shows how it is joined by the small intestine, and how the **vermiform appendix** (**App.**) depends from it. Refer to p. 200. It indicates how the large bowel passes up on the right side as the **ascending colon** (**As.C.**), turns sharply under cover of the ribs, passes across, above the **navel** (**U.**) and below the stomach, to the left side, curving slightly upwards behind the stomach, in the region of the **spleen** (**Spl.**), and how it takes then a sharp turn downwards, as the **descending colon** (**Des.C.**), in the region of the left groin, where it makes an **S**-shaped bend, the **sigmoid flexure** (**Sig.Fl.**), and ends in the straight part or **rectum** (**R.**) that leads to the outlet.

The relation of these terminal portions of the bowel to the middle line of the body and the **navel** (**U.**) on the one side, and the left groin on the other side, is well shown in the plate.

PLATE XII



THE TOPOGRAPHY OF THE STOMACH AND BOWELS

(FRONT VIEW)

belong to the class called **racemose**, from their resemblance to a bunch of grapes. They have little channels or ducts, which give off smaller and smaller branches, the smallest branches ending in little pouches or sacs lined with cells, as the stem of the vine gives off smaller stems which end in the pouch of the grape. Groups of the little pouches are bound together by connective tissue, through which blood-vessels pass. Thus the blood stream is brought so near to the cells of the pouch that they can derive from it whatever materials they need for their nourishment and activity. From the blood the cells derive the raw material which they work up into the substance which it is their business to produce. This substance — the **saliva**—is then conveyed along the small channels or ducts till the common duct is reached which carries the fluid into the mouth. Nerves are also freely distributed to the glands, and it has been found that the activity of the gland is largely regulated by the nerves. Fine filaments of nerves have even been traced to the very cells that line the pouches of the gland. The main duct which conveys away the fluid saliva from the parotid gland (Stenson's duct) opens on the inner surface of the cheek on a level with the crown of the second molar tooth of the upper jaw, where it may be often felt as a slight swelling. The duct of the submaxillary gland (Wharton's duct) opens at the summit of a soft papilla under the tongue. The ducts of the two glands—one of each side—are readily seen on turning up the tip of the tongue. The sublingual glands have a considerable number of ducts opening in the neighbourhood of Wharton's. The purpose of the fluids poured into the mouth from these glands is discussed further on.

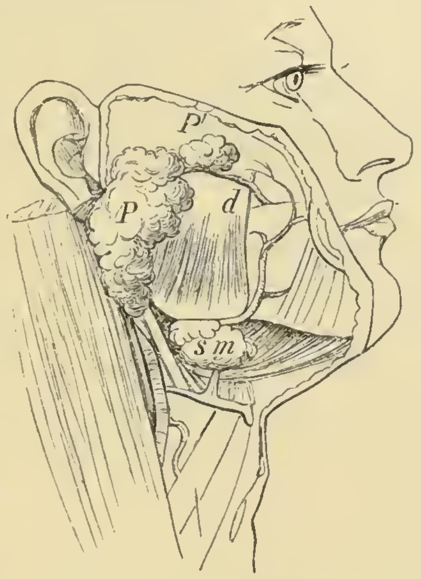


Fig. 103.—The Salivary Glands.

P P′ Parotid, *sm* sub-maxillary. *d* is placed below the duct of the parotid.

The Pharynx is the upper end of the alimentary canal, and it forms a blind sac above the level of the mouth (*ph*, Fig. 101). The mouth opens into it, and straight above that opening there are two openings, by means of which the nasal cavity communicates with the pharynx. About the same level as the openings into the nasal passages are two apertures, one at each side, which are the mouths of the Eustachian tubes, which pass upwards to the cavities of the ears, the cavity of each side being on the inner side of the drum of the ear. By referring to Fig. 101 it will also be seen that the windpipe opens upwards into the pharynx, but that this communication can be shut off by the lid of the windpipe (*ep*)—the epiglottis—folding down. Thus there are six openings into the pharynx, and the gullet is the direct continuation of it downwards to the stomach. When one opens the mouth widely before a glass, the back wall seen through the narrowing of the fauces is the wall of the pharynx. The mucous membrane of the pharynx is continuous forwards with that of the mouth, upwards with that of the nostrils and tubes leading to the middle ear, and downwards with that of the windpipe and gullet. It is thus that an inflamed and swollen condition of that membrane, which may have begun as a sore throat, may travel into the nose, may impede the passage of air into the Eustachian tubes, blocking them, and so producing deafness, and down into the windpipe, causing irritable throat and coughing. In the membrane is a large number of glands, the excessive secretion and enlargement of which are so troublesome in relaxed and other conditions of the throat.

The Gullet or **Œsophagus** (*g*, Fig. 101) is the continuation of the pharynx downwards to the stomach. It is about 9 or 10 inches long, and lies behind the windpipe in the neck and upper part of the chest. It passes through the chest, pierces the muscular partition dividing off the cavities of chest and belly, and opens into the stomach. The gullet contains a thick layer of muscular fibres in its walls, which are capable of contracting like other muscular fibres, and so of diminishing the diameter of the tube. As we shall see, it is by such contractions that the food received from the mouth is passed downwards into the stomach.

The Stomach is simply to be regarded as a dilated portion of the alimentary canal. Reference to Fig. 100 and its accompanying description show it to occupy a part of the epigastric and left hypochondriac regions of the abdomen. The following figure (104) shows how much of the stomach is in direct contact with the front wall of the belly, and how much is covered by the diaphragm (C) above, and the liver (D) to the right. The shape of the stomach is shown in Fig. 99, where *a* marks the entrance of the gullet, and *c* the junction of stomach and small intestine. That figure shows it to be pear-shaped with the large end to the left and the small end to the right. The large end is called the cardiac end because it is to the heart side. Thus the main bulk of the stomach is under the ribs to the left side.

Reference should also be made to Plates XII. and XIII.

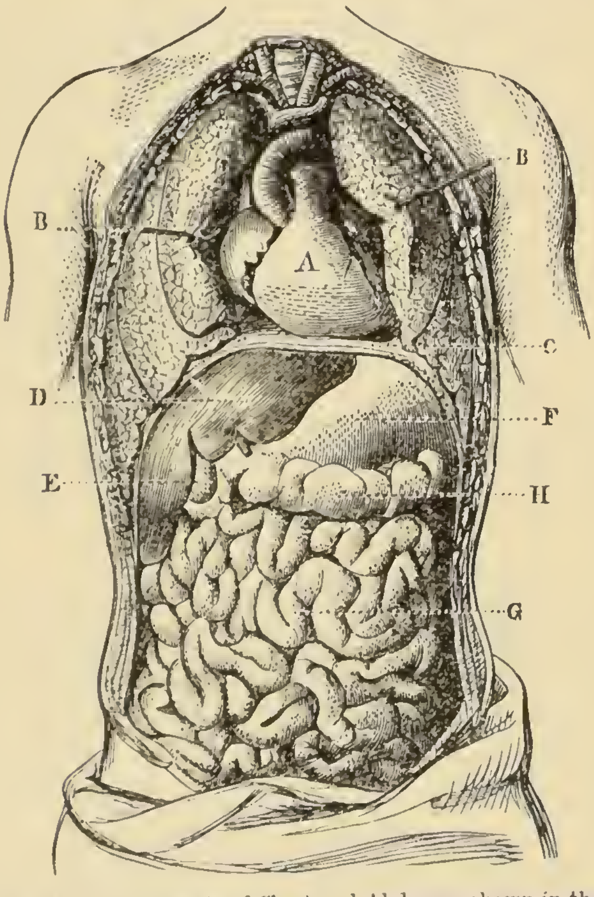


Fig. 104.—The Contents of Chest and Abdomen shown in their Positions.

A, heart; B B, lungs; C, diaphragm, the horizontal partition between chest and belly; D, liver; E, gall-bladder; F, stomach; G, coils of small intestine; H, cross part of large intestine.

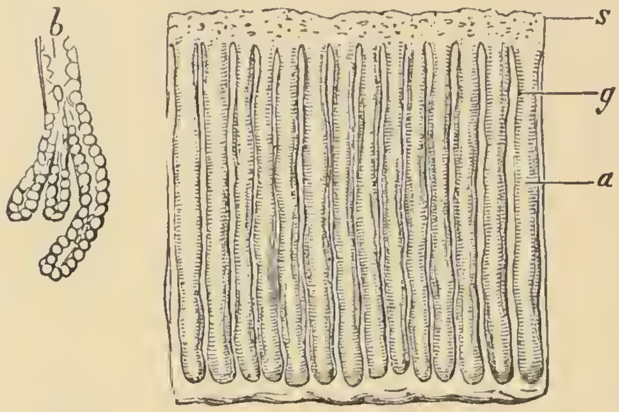


Fig. 105.—The Mucous Membrane of the Stomach, highly magnified.

s points to the surface, *g* to one of the tubular glands, of which *a* indicates the central canal. *b* is a much more highly magnified view of one gland, which is represented as giving off branches.

The walls of the stomach are composed of several layers or coats. The most important of them are the middle coat of muscular fibre of the involuntary kind, whose contractions produce movements of the walls, and the internal coat or mucous layer continuous with the mucous lining of the gullet. The mucous layer is thrown into folds, and thus a wrinkled appearance is presented by the inner surface of the stomach. The surface of the membrane is lined with columnar epithelium (p. 55). The important parts of the mucous lining, however, are the glands, which, in the form of fine wavy tubes, are buried in the substance of the membrane, and open by their mouths on the surface. The appearance of a section of the wall of the stomach when examined by a microscope is seen in Fig. 105; and in the upper corner one of the tubular glands is represented highly magnified. Each gland is found to be a more or less simple tube lined with columnar cells. **Peptic or gastric glands** they are called. Now in the mucous membrane there runs up between the rows of glands a large number of very minute blood-vessels conveying very fine streams of blood. Thus there are reproduced the conditions observed in the salivary glands, namely, a stream of blood separated by only its thin wall and other fine tissue, including the wall of the gland itself, from actively growing and working cells. The cells find, therefore, within easy reach, a current from which they may abstract what they require for their continued life and activity. It is a curious fact that when the stomach is empty, and therefore doing no work, the mucous membrane, if it could be seen, would be found to be pale; but whenever food enters it the membrane speedily assumes a rosy tint, due to a larger quantity of blood rushing into and dilating the fine vessels that pass up between the glands. A little time after, drops of fluid collect at the mouths of the glands and trickle down the walls of the stomach to mix with the food; so that the cells of the glands are thrown into a condition of increased activity by increased quantity of blood supply, and as a result they produce a quantity of fluid—the **gastric juice**—whose purpose is to aid in the digestion of the food. How it does this will be considered further on (p. 203). On looking down on the surface of the stomach with a simple lens, little pits or depressions of an irregular form will be seen, and at the bottom of the depressions dark dots; the dark dots are the mouths of the gastric glands.

The Small Intestine is continuous with the stomach at its small end. At this point (*c* of Fig. 99) there is a band of circular muscular fibres which keeps the way of communication closed, acting, therefore, as a valve, and called the **pyloric valve.** At appropriate times the fibres are relaxed, and food digested in the stomach is permitted to pass into the small intestine. The first part of the small bowel, about 12 inches long, is called **duodenum** (Latin, *duodecim*, twelve) (*c d*, Fig. 99). Into this portion, about the middle, there open the bile-duct from the liver, and the duct from the pancreas (sweet-bread), a gland which lies behind the stomach, the large end of which fits into the crescentic curve formed by the duodenum. The succeeding portion of the small intestine has been subdivided into **jejunum** and **ileum,** though there is no distinction between these. The ileum is the last part of the small intestine; and it opens into the large bowel lying in the right iliac region (8, Fig. 100, p. 190). The opening is guarded by folds of the mucous membrane forming the **ileo-cæcal valve,** to permit the passage of material from the small to the large intestine, but to prevent its backward passage.

The walls of the small intestine consist of similar layers to those of the stomach, but with some remarkable alterations. Like the stomach, the small intestine has muscular layers by whose contraction food in the intestine is propelled onwards. On opening a part of the small intestine and floating it out in water, the inner coat — the mucous membrane — is seen to be thrown into transverse folds, which are called **valvulæ conniventes,** by which the internal surface of the small bowel is increased. The surface is found to have a velvety feeling, due to innumerable very fine projections termed **villi.** On examining the surface with a microscope these projections take the form of finger-shaped processes from the mucous membrane. They are represented in Fig. 106 (*a*). A very highly magnified view of a single villus is given in Fig. 107, where it is represented as covered with a layer of columnar cells, nucleated. The centre of the projection is formed of very delicate tissue, containing a network of small blood-vessels (*b* and *c*). Besides these, in the very centre is seen a larger vessel (*d*) with a blind extremity. This is the beginning of a **lacteal** vessel, so called because it does not contain blood, but a milk-like fluid (*lac*, milk) obtained from the food in the canal of the intestine. In fact the lacteal is a vessel for absorbing, sucking up, certain of the nourishing parts of the food and conveying them away to other communicating vessels, by which they may finally be poured into the current of blood. This will be referred to again in speaking of absorption. Apart from these projections from the mucous surface, the small intestine presents appearances not unlike those of the stomach. Thus, buried in the substance of the mucous layer, and opening on the surface at the bases of the villi, is a series of tubular glands (Fig. 106, *b*), lined with columnar cells. They are called **Lieberkühn's glands,** after the anatomist who first described them; and they pour out the **intestinal juice.** The bases of the glands rest on a fibrous tissue (*c*, Fig. 106) between them and the muscular layers of the bowel (*d* and *e*). These glands are found throughout the length of the small and large intestines; the villi, however, diminish greatly in number in the lower parts of the small, and are quite absent in the large, intestine. Towards the beginning of the duodenum a few glands, in clusters like grapes, are found. They are called **Brünner's glands,** but their function is not known. Embedded in the mucous membrane, also, are found groups of little glands, which are in the shape of closed sacs, with no duct or other means of communication with the cavity of the intestine. The closed sacs contain cells and blood-vessels, and are of the size of millet seeds. They are found in patches — **Peyer's patches**—specially towards the lower end of the small intestine, but are also found singly here and there scattered over every part of the intestine.

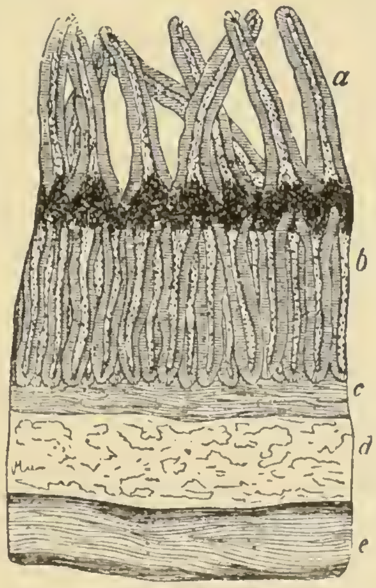


Fig. 106.—Microscopical Structure of the Small Intestine.

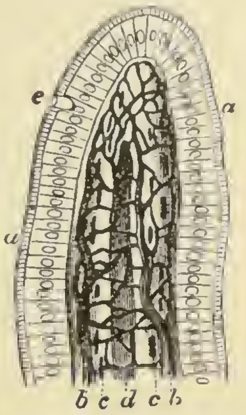


Fig. 107. — Villus of Small Intestine, magnified. *a*, columnar cells; *e*, goblet cell, modified columnar.

The Large Intestine begins in the right iliac region. The small intestine joins it at right angles, and not precisely at its extremity, so that a blind end projects beyond the place of junction—the **cæcum** (Latin, *cæcum*, blind). From the place of junction the large intestine passes upwards on the right side, as the

ascending colon, till the under surface of the liver is reached, where it turns and proceeds across to the left side, as the **transverse colon**, below the stomach. Having reached the left side it turns downwards as the **descending colon** to the sigmoid bend and the rectum (Fig. 99, p. 189). The large intestine is altogether 5 or 6 feet long. It is much wider than the small intestine. The longitudinal muscular fibres are collected into three bundles, which, being shorter than the canal itself, produce a series of pouches or bulgings in the wall, represented in Fig. 99. These pouches delay the progress of the remains of the food, and so permit the nourishing materials to be completely removed. The large intestine possesses no folds like the small, and no villi. It has, however, the glands of Lieberkühn in its mucous coat. Glands of Peyer are also found in the large intestine. The termination of the large intestine at the anus has been already noted on p. 189.

Attached like a tag to the blind extremity of the large bowel is the appendix, having in miniature, so to speak, the same structure as the rest of the bowel wall. In its centre is usually a fine canal, communicating with the main canal of the bowel, and at the free extremity of the appendix this very fine canal may be open.

Refer to Plates XII. and XIII. to see normal position of appendix from front and back view.

The Blood-vessels of the abdominal portion of the alimentary canal have rather a peculiar arrangement which it is desirable to note here. The stomach, intestines, spleen, pancreas, and the mesentery as well, all receive pure arterial blood from branches of the main artery that passes down along the front of the backbone. This blood circulates through the various organs in tiny streamlets. In particular it has already been noted that it is from such arterial blood supply that the glands in the stomach and intestines derive the material for their activity. The blood, after passing through the organs, is collected into veins. Thus the stomach has its own set of veins carrying the blood *away* from it; the intestines have their set, the spleen and pancreas likewise. Ultimately, however, the veins from these different organs unite to form one large vessel, the **portal vein**, which passes to the liver. The liver thus receives all the blood which has previously circulated through the stomach and intestines, which blood, as we shall see, is charged with nourishing material obtained from the food by the process of endosmosis explained on page 194.

The **Liver** must also be counted as a part of the digestive apparatus, since it forms the bile, one of the digestive juices. It is the largest gland in the body, and weighs from 50 to 60 ounces avoirdupois. It is placed just below the diaphragm and on the right side, as may be seen on reference to Fig. 104, p. 198. It extends also across the middle line of the body towards the left side. Its front border reaches just below the border of the chest when a person is sitting or standing; but when the person lies the liver passes slightly up so as to be completely under cover of the ribs, except for a small portion beyond the lower end of the breast-bone. In women, by tight lacing, the liver is often permanently displaced, forced downwards out of cover of the ribs. This causes crowding in the abdomen and pelvis, and may serve to displace other organs, notably the womb. When a small piece of liver is examined under a microscope it is found to consist mainly of large many-sided cells, containing a large nucleus and a nucleolus. The cells are represented in Fig. 108. The protoplasm of which they consist is very granular, and frequently exhibits a large number of minute bright dots—oil globules. The cells are faintly yellow in colour, and measure the $\frac{1}{1000}$th of an inch in diameter. They are disposed in groups or masses, each little mass being called a *lobule*. When a single lobule is examined it appears to be of an irregularly circular shape, and the cells are arranged in it in rows which seem to radiate from the centre to the circumference of the lobule. It is the lobules that give the liver its coarse granular appearance when torn. It has been mentioned above that the **portal vein** comes to the liver carrying blood full of nourishing material obtained from the stomach and intestines. When this vein reaches the liver it breaks up into branches, which pass into the substance of the organ, giving off smaller and smaller branches as they go. The smallest branches of the portal vein reach the *circumference* of the lobules, and from this surrounding vessel fine streams of blood pass inwards among the cells to the centre of the lobule, where they reunite into one vessel, a branch of what is now called the **hepatic vein** (*hepar*, the liver). The *central* vessels of the lobules unite to produce larger and larger veins till one vessel is

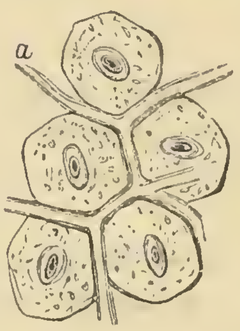


Fig. 108.—Cells of the Liver (very much magnified) with channels (*a*) for the bile between.

PLATE XIII

THE TOPOGRAPHY OF THE STOMACH AND BOWELS

BACK VIEW

This plate illustrates the position of the digestive organs by means of their outlines projected on the back of the body.

The description of Plate XII should first be read.

The bony landmarks here are the **shoulder-blade** (**S.**), the bone of the upper arm (H.), and the outer end of the **collar-bone** (**C.**), where they form the shoulder with the shoulder-blade; the spines of the back-bone, 2, 3, 4, &c.; the first series of the neck, the second of the chest, the third of the lumbar region; and the wing-shaped expansion of the **iliac bone** (**I.**) of the haunch.

The blue outline represents the space filled by the lungs; and the wind-pipe, and right and left bronchial tube are shown.

The orange outline is the gullet continued into the **stomach** (**Sto:**), and with portions of the small and large **intestine.**

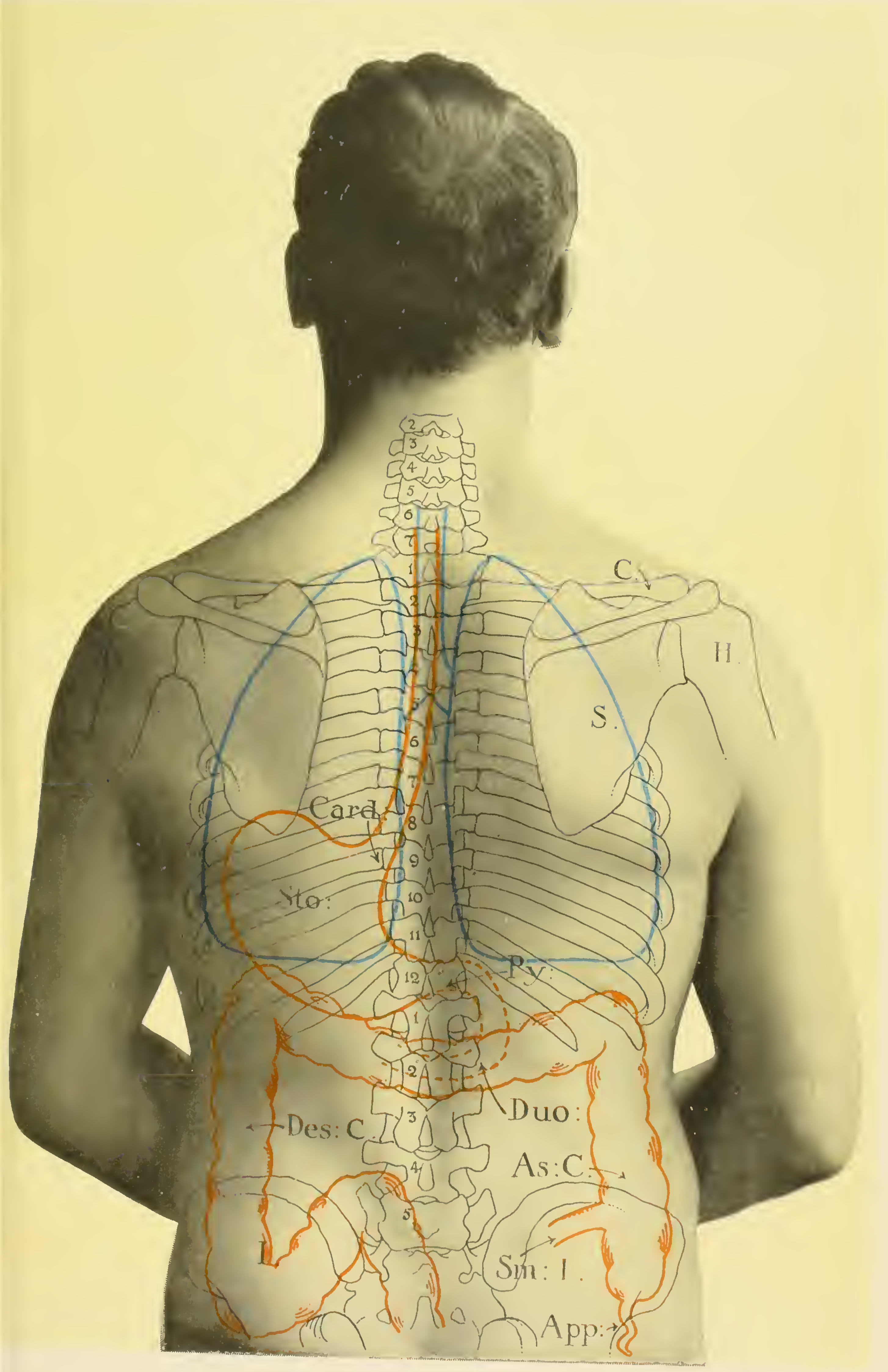
The gullet is shown beginning at the level between the 6th and 7th spines of the neck, and ending at the **cardiac opening of the stomach** (**Card:**) at the left of the 9th dorsal spine.

The large curve of the stomach is shown to the left, and its opening into the small bowel at the **Pylorus** (**Py:**) to the right of the 12th dorsal spine. From there the curve of the first part of the small intestine—the **duodenum** (**Duo:**)—is represented in dotted outline downwards to the level of the 2nd lumbar spine.

The junction of the **small intestine** (**Sm:I.**) in the right iliac region, its relation to the ascending part of the **large intestine** (**As:C.**) and the **Appendix** (**App.**) are shown; its passage across from the shelter of the ribs on one side to similar shelter on the other, and its prolongation downwards, as **descending colon** (**Des:C.**) are indicated.

This plate should be studied with the preceding one.

PLATE XIII



THE TOPOGRAPHY OF THE STOMACH AND BOWELS

(BACK VIEW)

formed which carries all the blood *away from* the liver upwards towards the right side of the heart. The portal vein is thus formed by a set of capillary (hair-like) blood-vessels in the stomach, intestines, &c., and splits up into a similar set in the liver, which in their turn give rise to the hepatic vein. It is to be noted that neither of these vessels carries arterial blood. Yet the liver is not without its supply of such pure blood, brought to it by an artery—the **hepatic artery**—which enters the liver and distributes its blood, not to the cells, but to the connective tissue of the bile-ducts and vessels in the organ, the blood afterwards finding its way, like that of the portal vein, into the hepatic vein.

Besides these branches of the portal and hepatic veins and hepatic artery another set of vessels ramifies in the liver, namely the **bile-ducts**, whose business it is to carry off the bile produced by the activity of the cells. A very remarkable and interesting experiment, performed by a Polish anatomist named Chrzonszczewsky, shows where the bile-ducts originate. This investigator injected into the veins of some animals a particular dye, indigo-carmine. An hour and a half afterwards the animal was killed, and examination of specimens of the liver under the microscope displayed the colouring matter collected round the cells of the liver in channels which were thus for the first time revealed. If the animal were killed sooner, the colouring matter was found in the cells themselves. It thus became apparent that the liver cells seized upon the colouring matter in the blood brought to them, separated it out, and passed it into channels surrounding them. The channels are shown in Fig. 108 (*a*). They are the beginnings of the bile-ducts. It may be supposed that, in a similar fashion, the cells of the liver take from the blood flowing past them certain materials from which they prepare the bile, which is then discharged into the surrounding ducts. From them the bile passes from between the cells out of the lobule into larger ducts, which collect the bile from numerous lobules. These ducts unite with others from other parts of the liver until, in the end, two channels are formed, one of which carries all the bile formed by the right portion of the liver, and the other that from the left portion. These two ducts come out from the substance of the liver and soon unite into one main vessel—the **hepatic duct**, which passes towards the small intestine. On the under surface of the liver is the gall-bladder, in which the bile may be stored till needed for digestion. From the gall-bladder a duct passes—the **cystic duct.** It joins the duct from the liver, and the **common bile-duct**, formed by the junction of the two, reaches the first part of the small intestine, through whose walls it passes to open on the inner surface a few inches below the stomach. The bile, then, prepared in the depths of the liver by the liver cells, is conveyed out of the liver by the bile-ducts, and may pass straight down and into the small intestine to mingle with the food. If, however, digestion be not going on, the mouth of the bile-duct is closed, and in that case the bile passes up the cystic duct and lodges in the gall-bladder till required.

Fig. 109 shows the connections of the various parts spoken of, and the figure should be studied in the light of the above explanations.

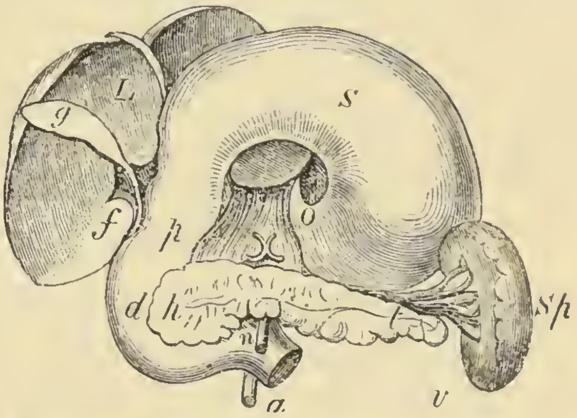


Fig. 109.—Relations of the Stomach to the Liver, Pancreas, and Spleen.[1]

Plate XIV. represents the relationship between the liver and its duct and gall-bladder, and between these and the stomach and small bowel. In particular, it may be here pointed out how near to the small end of the stomach is the place where the bile-duct pours the bile into the small bowel. It will easily be understood how, by the act of retching, the pressure exerted on the gall-bladder, &c., may force bile up from the bowel into the stomach, the reverse of its usual direction. From the stomach it would then be ejected by vomiting. Under such circumstances a person is apt to attribute his retching to bile, whereas it was the retching that forced the bile up into the stomach, and the cause of the sickness may therefore have been elsewhere.

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[1] The stomach is represented turned up, *S* being on its under surface. *p* indicates the junction of stomach and duodenum (*d*) at the pylorus. *O* is placed at the junction of stomach and gullet. *L* is on the right portion of the liver, which is also turned up to show *g*, the gall-bladder. *f* is placed to the side of the common bile-duct formed by ducts from the liver and gall-bladder. *h–t* is the pancreas, revealed by the turning up of the stomach. *Sp*, spleen. *v*, the part where blood-vessels are connected to the spleen. *n* and *a*, blood-vessels.

The **Pancreas** is a much smaller gland than the liver, weighing not more than 2 or 3 ounces. It lies behind the stomach, and its large end or head lies in the curvature formed by the duodenum. Its position is well shown in Fig. 109, where the stomach is represented turned upwards to permit it being seen, and in Plate XIV. In its structure it resembles the salivary glands (p. 196), its ducts terminating in recesses lined with large cells which prepare the juice of the gland. The main duct of the gland runs from one end of the organ to the other, collecting the materials from numerous smaller channels on the way. It finally issues from the gland to pierce the back wall of the small intestine in company with the common bile-duct, and thus is able to pour its secretion among the food which has passed down from the stomach.

THE DIGESTIVE PROCESS

We have considered the character and structure of the digestive apparatus, the tract along which the food is conveyed, and the various glands in connection with it; and we have seen that these glands pour various juices into the canal to mix with the food, namely the saliva, gastric juice, bile, pancreatic juice, and intestinal juice. Let us now consider the changes undergone by the food as it passes along the digestive tract, and the part these juices and other agencies play in the change.

Mastication is the first part of the process to which the food is submitted. By this is meant the breaking down of the food by means of the teeth. In some animals, such as the tiger, the lower jaw is movable on the upper in one direction mainly, an upward and a downward movement that permits of tearing the food. In other animals, such as the cow, the movement is from side to side, the grinding teeth being specially employed. In man, however, owing to the shape of the joint between the lower and upper jaws, the lower is movable in many directions, so that a cutting or tearing and a grinding movement as well is permitted. While the food is being thus broken down it is moved about and mixed by movements of the tongue and cheeks, so that every part of it may come under the operation of the teeth. The advantage of this is obvious. The more completely the food is separated up into small portions the more easily will the digestive fluids reach every particle of it, and the more thorough and speedy will digestion be. The disadvantage, then, of "bolting the food" ought to be apparent. If the breaking-down process is not accomplished in the mouth it must be performed by the stomach, and the stomach has no apparatus for such a purpose. Children in particular, who are very prone to swallow their food almost without chewing it, should be trained to take time to do this part of their eating thoroughly.

Insalivation.—While chewing is going on, the saliva is streaming into the mouth, and is being intimately mixed with the food, and to this the term insalivation is given. The **saliva** is a colourless fluid, without smell or taste. It contains in solution very few saline matters, only about 5 parts in 1000. Its principal element, besides water, is a substance called **ptyalin**, which is a ferment, and possesses the remarkable property of being able to convert starch into sugar. As much as 48 ounces of saliva may be poured into the mouth daily. Thus in the mouth, and while chewing is being performed, another process is going on which has for its purpose the conversion of starch, which cannot dissolve in water, and cannot pass through an animal membrane, into sugar, which can do both. Besides effecting this object, saliva also moistens the food so as to enable it to be made up into a consistent mass fit for swallowing. Saliva aids also in speech by moistening the mouth.

Deglutition.—The food having been thoroughly broken down and mixed with saliva is in a proper condition for deglutition or swallowing. The tongue gathers it up into a bolus or mass and forces it backwards through between the pillars of the fauces into the pharynx, by whose muscles it is grasped. Now, having reached the pharynx, the food, it is easy to see, might be forced in various directions by the contractions of the constricting muscles of the pharynx. Reference to Fig. 101, p. 195, will explain how this comes about. Thus it might be forced back again into the mouth. This is prevented by the contraction

PLATE XIV

THE TOPOGRAPHY OF LIVER, SPLEEN, AND PANCREAS

This plate should be studied with Plate XII. It is meant to indicate the relations between stomach and bowel and liver, spleen, pancreas, and gall-bladder.

The landmarks are as described on Plate XII.

The **liver** (**L.**) is indicated as lying in its main bulk under cover of the ribs on the right side, but also as extending across the middle line to the left side.

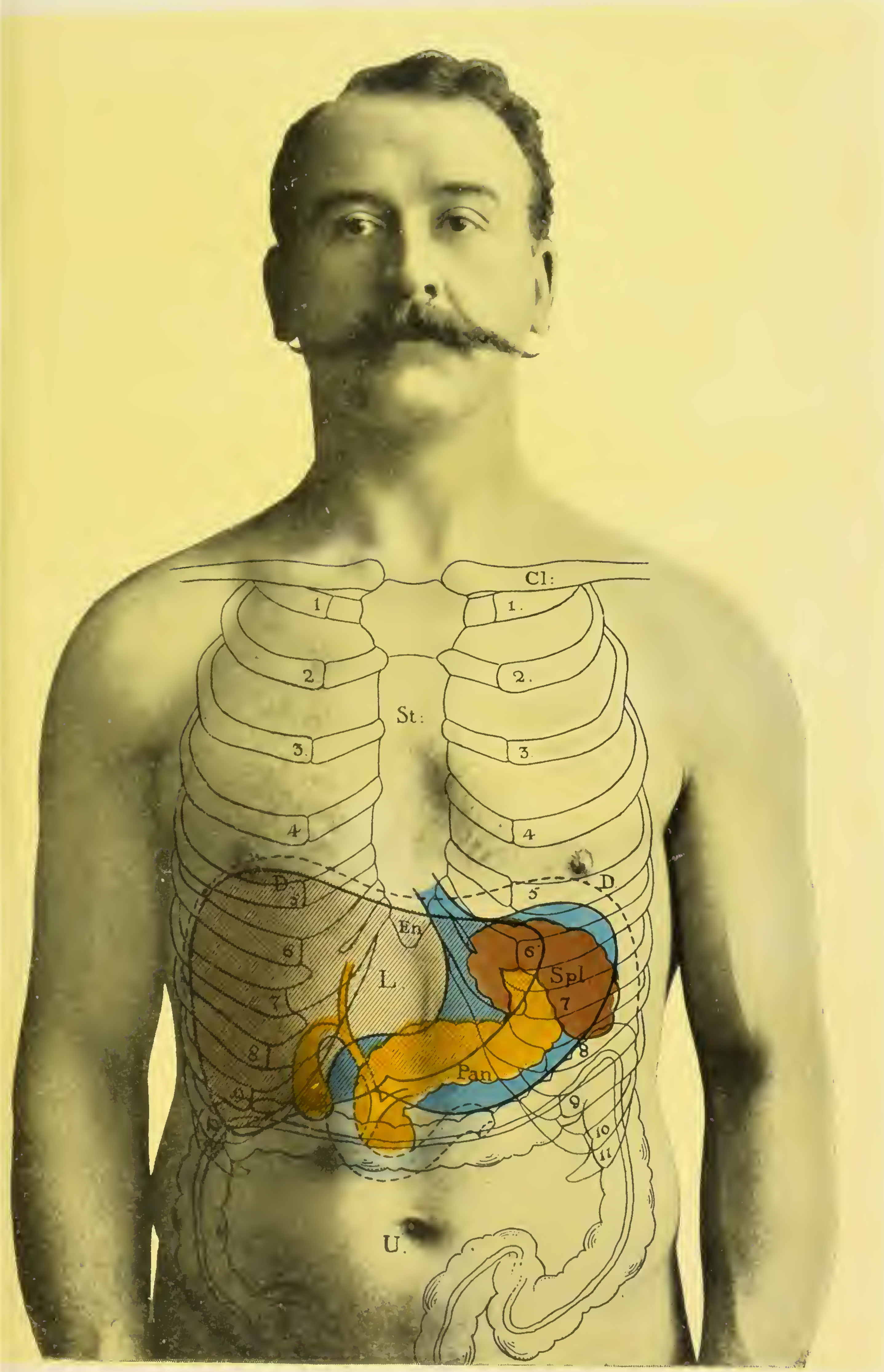
A line drawn from the rib edge of the right side, opposite the 9th rib, to the rib edge of the left side opposite the 8th rib, will indicate the direction of its lower margin, and a line drawn from the upper edge of the 5th rib of the right side, just below the right nipple, to the upper edge of the 6th rib of the left side at a point between the outer edge of the breast-bone and left nipple, will indicate its upper margin.

The notch which indicates the division between the right and left lobes of the liver is just to the right of a straight line dropped from the right edge of the breast-bone.

The stomach with the duodenal portion of the small intestine, fully described on Plate XII, are shown in blue, and the pancreas or **sweetbread** (**Pan.**) and spleen or **melt** (**Spl.**) are indicated as lying behind the stomach, the head of the pancreas nestling into the curve of the duodenum (see p. 202) and its tail stretching upwards and to the left into the embrace of the spleen (see p. 280). It will be noticed that this head of pancreas in the duodenal curve lies just to the right of the middle line, and about midway between the end of the **breast-bone** (**En.**) and the **navel** (**U.**).

The plate tries to indicate that these parts lie above and behind the transverse portion of the large bowel.

The plate indicates also how the **gall-bladder** is situated under cover of the front part of the liver, the top end of the gall-bladder just peeping out from the lower edge just opposite the end of the 9th rib. The plate roughly shows how the channel from the gall-bladder—the **cystic duct** (see p. 201)—joins the main duct from the liver—**hepatic duct** (see p. 201)—to form the **common bile duct**, and how this passing behind the duodenum joins the duct from the pancreas, the two forming a common opening which pierces the wall of the duodenum lower down.



THE TOPOGRAPHY OF THE LIVER, SPLEEN, AND PANCREAS

of the front pillars of the fauces and the backward pressure of the tongue. The food might pass upwards and get through the openings of the nasal cavity behind. This is prevented by the back pillars of the fauces contracting and the soft palate being raised to bar the way. It might pass down into the windpipe, but this is also prevented by the box of the windpipe being quickly raised up under cover of the root of the tongue. The elevation of this part of the windpipe anyone may feel by putting a finger on the front of the neck and then swallowing. At the same time as the windpipe is thus raised, its lid, the epiglottis (*ep*, Fig. 101), is lowered so as to cover the entrance. The food has thus only one pathway, namely, down the gullet. When it has been forced into this tube the walls contract in a wave-like fashion, and thus propel the food onwards to the stomach. The food does not then fall into the stomach from the mouth. It is swept along the gullet by the muscular wave. This is why a horse can drink though its mouth be below the level of its gullet, and why a man can drink standing on his head. Some of the movements that have been described are under the control of the will, some are involuntary. The forcing of the food backwards is voluntary; but as soon as it has entered the pharynx all the other movements will occur in due order whether we will it or not. They are accomplished by a reflex nervous action (p. 132).

Digestion in the stomach.—As soon as the food reaches the stomach that organ becomes active. By the contractions of its muscular walls the food is moved about, and mixed with gastric juice poured out of the gastric glands as described on page 198. The action of the juice is aided by the heat of the parts. The gastric juice is acid owing to the presence of a small quantity of acid, usually hydrochloric acid. It contains, besides, a ferment called **pepsin**. It is owing to the presence of the acid and pepsin in the stomach that digestion is performed. The action of the juice is on albuminous substances. Now albuminous substances are not soluble in water, nor can they pass through animal membranes, but by the action of the juice they become converted into what are called **peptones**, which are both soluble and capable of passing through membranes. The juice of the stomach has an action on fat to this small extent, that fat consists of a drop of oil in an albuminous sac, and by the juice this sac becomes dissolved, so that the oil is freed, but no further action on it is effected. Thus it is only on albuminous food-stuffs that gastric juice acts. As a result of the action in the stomach the food becomes converted into a semi-fluid mass called **chyme**.

Digestion similar to that performed in the stomach can be artificially produced. An acid solution of pepsin is required. This is obtained in the following way. The stomach of a pig is taken, opened up, and very gently washed with a stream of water. The inner coat—the mucous membrane—is then stripped off, cut into very small pieces, placed in a bottle among glycerine and water containing a small amount of hydrochloric acid ($1\frac{1}{2}$ drachm to every 100 ounces). It is allowed to stand for several days. The glycerine-and-acid solution extract the pepsin from the glands of the stomach. If now some small pieces of boiled meat, boiled egg, fish, &c., be put into a glass vessel with some water, and if a small quantity of the glycerine extract of pepsin be added, and the whole kept at the temperature of the body—about 100° Fahr.,—in a few hours the meat will have undergone digestion. Pepsin wine may be made by adding sherry wine to the glycerine extract. The pepsin powder that may be obtained from chemists is prepared from the pig's or calf's stomach. Besides pepsin, another ferment is contained in the gastric juice, called **rennin**, which produces a curdling action upon milk. Rennet, which is used for curdling milk, is a preparation of the calf's stomach, and owes its property to the rennin it contains. Indeed, what happens to milk on the addition of rennet is precisely similar to what happens to milk passed into the stomach. Owing to the acid of the stomach and rennin, aided by the heat of the parts, the milk is curdled, and separates into curd and whey. The curd contains the main albuminous constituent of the milk, casein, which the pepsin forthwith proceeds to attack. It is thus *seen that the curdling of milk in the stomach is a first and essential part of the process of digestion.* This it is desirable to note, because many mothers, after permitting a child to drink too much milk, are alarmed to see the child, after some time, vomit curdled milk. The vomiting does not alarm them, but the curd does. The explanation usually is that the stomach, being overloaded, rejects some of the milk in a curdled condition, because it has already come under the influence of the gastric juice.

Conditions of digestion in the stomach.

The acid is as necessary to the process as the pepsin, for it has been shown in artificial digestion that pepsin alone cannot act upon albuminous food in a proper way. Hence if the gastric juice be too feebly acid, or if the acidity be destroyed by soda or other alkalies, for instance, digestion will be imperfect. But an excess of acid equally interferes with the process; thus what is called "acidity of the stomach" produces indigestion in this way. Excess of alcohol also impedes the process.

Overfulness of the stomach will impede the movement of the walls, and therefore the mixture with the juice, and so hinder digestion.

It has been seen (p. 198) how a due supply of blood is necessary for the formation of the digestive fluid. If the blood be occupied elsewhere, as it may be if active exercise be engaged in immediately after food, there may be insufficient for digestive purposes, and a delay in the process results. The secretion of the juice is also undoubtedly under the control of the nervous system. For this reason, no doubt, active brain work immediately after food, either by diverting the nervous activity or by diverting the blood supply, the brain by its activity making great demands on both, may produce indigestion. Gentle exercise, therefore, and repose of mind, are conditions favourable for digestion.

It may be that owing to ill health the blood supply may be poor, and the nervous tone indifferent, so that indigestion may be only one symptom of general ill health.

The stomach, like all other organs of the body, should have periods of rest following its periods of activity, and these periods should follow one another regularly.

Time required for digestion.—Various kinds of food require varying times for digestion. This was proved by a remarkable set of experiments performed, in 1838, on a man named Alexis St. Martin, by Dr. Beaumont. St. Martin had an opening made in the front wall of the stomach by a gunshot wound. Even after complete healing of the wound a small opening was left through which the mucous membrane of the stomach could be seen, and through which substances could be introduced into the stomach or withdrawn from it. It was found that rice and tripe were digested most speedily, the time required being one hour. Eggs, salmon, trout, apples, and venison occupied an hour and a half; tapioca, barley, milk, liver, and fish, two hours; turkey, lamb, and pork, two hours and a half; beef, mutton, and fowls, about three and a half hours, and veal even longer. (Further details, p. 106, Vol. II.)

Absorption by the stomach.—We have seen that the mucous membrane of the stomach is richly supplied with blood-vessels. The blood flowing in them is separated from the semi-liquid food only by a thin animal partition. There is, therefore, no impediment to an interchange taking place between the blood and the food. What the nature of that change will be we have already learned (p. 194). Water, along with any substances in the food that have become dissolved, will pass through the partition and gain access to the current of blood. Thus a considerable quantity of salts in solution, of starch that has become converted into sugar, of albumin converted into peptone, will, without further delay, gain entrance to the blood. Starch that has escaped the action of saliva, albumin that has escaped the action of gastric juice, and fats, will remain in the food, and will be passed on into the small intestine, where the digestive process is continued by other juices.

Digestion in the small intestine.—The chyme does not pass all at once from the stomach into the small intestine. It has been found that food already acted on by the gastric juice, if allowed to remain in the stomach, impedes the continuation of the process. The food seems to be digested in the stomach in detachments, and as soon as a portion has become sufficiently digested the pyloric valve, that we have noted (p. 199) as guarding the communication between stomach and small intestine—the pyloric valve opens, permits that portion to escape into the small intestine, then closes, and opens again as soon as a further quantity of food is ready. The stimulus of the food passing over the openings of the bile and pancreatic ducts causes a discharge of bile and pancreatic juice, which proceed to mix with the food and act upon it.

The pancreatic juice is alkaline, and contains several ferments: one of them, like saliva, converts starch into sugar; another, like the gastric juice, converts albuminates into peptones, and may even proceed further and split up peptones into other bodies; and a third acts upon fats, making them into an emulsion or milk-like mixture, which is to some extent capable of passing through animal membranes, while fat cannot. Pancreatic juice seems also to split fats up into a fatty acid and glycerine, both of which can be absorbed. Thus starch which has escaped the saliva, and albumin which has escaped the gastric juice, are acted on by the pancreatic juice, and prepared for admission to the blood, the fat unacted on by either of the former juices not escaping the third.

The **bile** is also alkaline, and of a reddish-yellow colour. When it has been vomited it is distinctly yellow, because of the action on it of the gastric juice. As much as 2½ pounds weight of it may be poured into the small intestine of man in 24 hours. It contains a considerable quantity of colouring matter; and its chief ingredients are two salts of soda, the taurocholate and glycocholate of soda. Owing to the presence of these two salts the bile is capable of forming a soap with fat, and thus largely aids the pancreatic juice in enabling oil to become fit for absorption.

Owing to the action of these four juices, aided by the intestinal juice secreted by the tubular glands of the intestine (p. 199), the chyme becomes transformed into **chyle**. The chief distinctions between chyme and chyle are that the former is acid, the latter alkaline. In the former the oil floats in large globules; in the latter it is evenly diffused throughout the liquid as in an emulsion, and this gives to chyle its milky appearance. The chyle is propelled along the intestine by spiral (peristaltic) contractions of its muscular walls. A function of the bile not yet mentioned is to stimulate these movements, and at the same time to prevent putrefaction of the contents of the intestine. This explains how, when, in diseased conditions, bile is prevented passing into the small intestines, constipation results, and when the stools are passed they are badly smelling, and very light in colour, owing to want of the bile-colouring matter.

The special purpose of digestion in the small intestine is, then, the digestion of fat, while at the same time all the other food-stuffs are acted on.

Absorption by the small intestine.—The food is propelled along the small intestine, as we have seen, by movements of the muscular walls. The length of the tube is considerable—at least 20 feet—and it is richly supplied with blood along its whole course. Hence what we have observed to occur in the stomach will also occur here, water containing in solution salts, starch converted into sugar, and albumin converted into peptone, will be taken up directly into the blood. In addition some amount of changed fat will enter the circulation. We have noticed, however, special structures in the small intestine, namely, the villous projections (p. 199) containing a loop of blood-vessels, and another vessel—the lacteal. These are specially for the absorption of fat. They dip like fingers into the chyle, and the minute particles of oil pass through their cellular covering and gain entrance to the lacteal. The folds of the small intestine permit a large number of the villi to be present, and a large surface for fat absorption is therefore provided. Thus in the small intestine the nourishing portions of the food are withdrawn in two ways, (1) by blood-vessels and (2) by lacteals. The material that enters the lacteals joins the blood current later. It is conveyed by lacteal vessels through the mesentery to reach glands where it undergoes certain changes, and finally reaches a vessel—the **thoracic duct**—which passes up the front of the backbone to reach the root of the neck, where it opens at the junction of the great veins of the left side of the head and left arm. (See fig. 126, p. 278.) We see, then, that all the nourishing material obtained from the food sooner or later enters the blood.

Digestion in the large intestine does not occur to any great extent. The food enters this portion of the digestive tract through the ileocæcal valve situated in the right groin (p. 199). Although the great intestine is much shorter than the small, the remains of the food travel through it slowly, the pouches into which the walls are thrown preventing their speedy passage. Time is thus given for fluid matters to be abstracted by the blood-vessels of the mucous membrane. The remains of the food become consequently less fluid, and they acquire their characteristic odour. They are called **fæces**, and consist of undigested or indigestible materials, and of substances derived from the bowel itself, with a part of the bile from the liver. Propelled onwards by the contractions of the muscular walls, they at last reach the rectum, where their accumulation gives rise to the sensation that ends in the voluntary effort by which they are expelled from the body.

The **nervous relations** of digestion are not thoroughly understood. That digestion is controlled by the nervous system is quite certain. The salivary glands, for instance, have their activity regulated by nerves, some fibres of which find their way to the very cells of the glands. Such direct relationship is not known in the case of the other glands of the digestive tube. This we do know, however, that the formation of the digestive juices is directly dependent upon the quantity of blood supplied to the glands, and that the blood supply is controlled by nervous influence in a way that is explained in treating of the circulation of the blood. Conditions of the nervous system will, therefore, directly or indirectly influence digestion.

HUNGER AND THIRST.

Hunger and Thirst are two sensations connected with the alimentary function. Hunger is the call of the body for solid nourishment, and thirst the call for water.

Hunger is a sensation referred to the stomach, and, if not appeased, to the intestine later, and is relieved by the introduction into the stomach of a sufficient quantity of nourishing food. It may also be relieved, for a time, by passing into the stomach substances that are not nourishing. It does not seem, however, to be due to mere emptiness of the stomach, for, undoubtedly, after a full meal the stomach is empty for some time before there returns the **appetite** for more food, which is just a modified sense of hunger; besides, alcohol, tobacco, opium, and other narcotics restrain the sensation for some time. The nervous system influences the sensation in a remarkable way. We all know how persons, engrossed with work, may want food for many hours without experiencing any of the sensations of appetite or hunger, and how some impression on the nervous system, such as that caused by the sudden receipt of bad news, anxiety, &c., may abolish the sensation, or may delay its production for a long time. The desire for food may also be relieved by the introduction of nourishing material into the bowel, while hunger may continue even when the stomach is filled with food, if, owing to disease, the food is prevented passing onwards, and the process of absorption is interfered with. The sensation of hunger may become excessive even when food in sufficient quantity is regularly supplied. This is really a diseased condition, to which the term **bulimia** (p. 232) is applied. For the opposite condition, that of loss of appetite and distaste for food, the term **anorexia** is used. It accompanies most digestive disorders, fevers, &c.

Thirst is a sensation referred to the throat, and, while indicating a deficiency of liquids in the system, it may be produced by the action of drugs like opium, and specially belladonna, or its active principle atropia. Highly salted and spiced substances, by their action on the mucous membrane of the throat and other parts of the alimentary canal, also occasion the desire for water. Thirst is more clearly a general condition of the system than hunger, for it may be rapidly relieved by the passage of water into the blood from injections of water thrown into the bowel, or by the direct injection of water into the veins. The immersion of the body in water relieves for a time, and even the covering of the body with garments soaking with water.

If hunger and thirst are not satisfied, **starvation** arises.

THE FUNCTIONS OF THE LIVER.

The structure of the liver has been described on pages 200 and 201, and its function in digestion has been referred to on p. 205. But the part the liver plays in the digestive process is only one of its duties, and perhaps not the most important. The consideration of its other business is not properly included in a description of digestion. It is advisable, nevertheless, to have a complete view of all the functions of the liver in order to estimate the great importance of that organ in the bodily economy.

The Characters of Bile.—The functions of the liver are indeed not single, but several. As we have seen, it secretes the bile, and therefore ranks (1) as a *secretory organ*, an organ, that is, which elaborates a fluid for use in the body. But the bile is not wholly a digestive fluid. It aids in the digestive process, but it also contains ingredients which are separated from the blood, for the purpose of being *cast out* of the body, because their remaining in the blood would impair its quality. In respect of this the liver ranks (2) as an *excretory organ*, an organ, that is, which separates material of no use to the body, and which is destined to be expelled as waste matter. This will be more easily understood by noting, in detail, the constituents of bile. It contains roughly 86 per cent water, and 14 per cent solid matter. The solid matter consists (*a*) of the bile salts, the glycocholate and taurocholate of soda, (*b*) of colouring matters, (*c*) of fats, (*d*) of inorganic salts, chiefly chloride of sodium (common salt), with a smaller quantity of phosphates, and traces of iron and manganese, and (*e*) of a crystalline substance called cholesterin, a substance found in the brain, and seemingly brought to the liver by the blood. There is also in bile a considerable quantity of mucus, obtained from the bile-ducts and gall-bladder. These substances are in the following proportions:—

Water, ...		85·92 in 100 parts of bile.
Solids—		
Bile salts, ...	9·14	14·08 ” ”
Colouring matter and mucus, ...	2·98	
Fats, ...	·92	
Inorganic salts,	·78	
Cholesterin, ...	·26	

Of these the chief are the bile salts, and the colouring matters—the bile pigments. They do not exist already formed in the blood, as do the salts and the cholesterin, and must be formed from materials in the blood by the activity of the liver cells. Now it is the bile salts that act on fats in the alimentary canal and aid in their emulsion and absorption. They appear to be themselves split up into other substances and absorbed, for they are not found in the fæces. The colouring matter of bile is derived from the colouring matter of the blood. The pigment of human and carnivorous animals is **bilirubin**, of a golden red colour. In herbivorous animals it is **biliverdin**, a green pigment. The red pigment is readily converted by oxidation processes into the green. These pigments are cast out in the fæces. Their presence *in the blood* gives rise to the yellowness in cases of jaundice.

The Glycogenic Function of the Liver.—The third function of the liver is very different from those already considered. A French physiologist, Claude Bernard, was the first to point out that the liver formed a substance like starch, which was readily converted into sugar. He called it **glycogen**; it is also called **animal starch**. If an infusion of pieces of the liver of any animal be made, it will be found to be rich in sugar (grape-sugar, or *glucose*). But if the liver of an animal, just killed, be rapidly removed from the body and thrown into boiling water, an infusion does not contain sugar. It is opalescent or even milky. By adding alcohol to it a white precipitate of glycogen falls. If to the opalescent infusion saliva be added (which converts starch into sugar, p. 202), the infusion clears up, and sugar may now be detected in it—the glycogen has been transformed into sugar. Moreover, if water be injected into the portal vein (p. 200) of a liver, removed from an animal, and the injection continued till the water issues from the hepatic vein, sugar will be found in abundance in the water. If the injection be continued till the liver is well washed out, the washings will at last contain no sugar. If the liver be now left for a few hours, and then the injection repeated, sugar will again be found. It appears from such experiments, and many others, that the liver forms glycogen, which is stored up in the liver cells, and that it also contains a ferment capable of transforming the glycogen into sugar. The liver forms its glycogen chiefly from starch and sugar, taken as food, and passing as sugar to the liver by the portal vein. So far as can be learned, the fate of glycogen is to be gradually retransformed into sugar and sent to the tissues, as their needs demand, to supply them with material for their energy and heat. The liver thus has a great purpose to serve in the nutrition of the body. Its *glycogenic function*, as it is called, throws light on the disease *diabetes*, in which sugar appears in the urine.

Fat Formation by the liver. Fats may be formed or arrested by the liver-cells. Liver-cells usually exhibit bright dots of oil-globules (p. 200), which may so increase in number that the cell appears to contain nothing but fat. The liver of domestic animals, especially of those kept in confinement, tends to become very fatty. The luxury known as *pâté de foie gras* is made of the fatty liver of Strasburg geese. These animals are kept in close confinement and stuffed with rich food, so that the fatty degeneration speedily occurs.

Thus, then, the liver aids in the process of digestion by secreting the bile; it also separates certain waste substances from the blood, and it stores up in its cells substances (animal starch and fat) which are destined to take part in the general nourishment of the body.

SECTION XI.

THE DIGESTIVE SYSTEM.

ITS DISEASES AND INJURIES.

Diseases of the Mouth, Lip, Tongue, and Teeth:
- *Inflammation of the Mouth*—Ulcers—Thrush (Sprue)—Tumours (Ranulæ), &c.;
- *Hare-lip and Cleft-palate;*
- *Ulcers of the Lips, Growths, and Cancer of the Lip;*
- *Inflammation of the Tongue*—Pytalism—Ulcers, Cancer, Tumours, and Injuries of the Tongue;
- *Inflammation of the Gums*—Gum-boil;
- *Toothache*—Stopping of Decayed Teeth—Bleeding after Extraction of Teeth—Tartar of the Teeth—Care of the Teeth.
- *Inflammation of the Salivary Glands* (*Mumps, Branks, Parotitis*).

Diseases of the Throat, Tonsils, and Gullet:
- *Catarrh* (*Cold-in-the-Head*);
- *Inflammation of Tonsils* (*Tonsillitis, Quinsy, Sore-throat*)—Chronic Enlargement of Tonsils—Enlarged Uvula—Relaxed Throat—Adenoids;
- *Obstruction of the Gullet* (*Stricture*)—Difficulty of Swallowing (*Dysphagia*).

Diseases of the Stomach:
- *Indigestion or Dyspepsia:* Its Causes; Its Seat in the Stomach; Its Investigation by the Stomach-tube; Its Leading Symptoms; Its General Treatment.
- *Varieties of Stomach Indigestion*—Slow Digestion; Catarrhal Indigestion; Acid Indigestion; Flatulent Indigestion; Indigestion with Excessive Appetite; Painful Indigestion; Hiccough.
- *Special Affections of the Stomach:*
  - *Inflammation of the Stomach* (Gastritis) *acute* and *chronic*—Acute Gastric Catarrh;
  - *Ulceration and Cancer of the Stomach;*
  - *Bleeding from the Stomach* (*Haematemesis*);
  - *Dilatation of the Stomach.*

Diseases of the Bowels:
- *Intestinal Indigestion:* Its Causes and Varieties; The Conviction of the Bowel as its Seat; Its Investigation; Its Leading Symptoms and General Treatment.
- *Some Varieties of Bowel Disorder:*
  - Diarrhœa; Constipation; Colic.
- *Special Affections of the Bowel:—*
  - *Inflammation of the Bowels* (*Enteritis: Catarrh*);
  - *Mucous Catarrh of the Bowel; Appendicitis; Dysentery; Cholera;*
  - *Ulceration of the Bowels;*
  - *Obstruction of the Bowels*—Intussusception—Foreign Bodies;
  - *Consumption of the Bowels* (*Abdominal Phthisis, Tabes Mesenterica*);
  - *Bleeding from the Bowels* (*Melaena*);
  - *Cancer of the Bowels.*

Intestinal Worms:
- *Tapeworms* (*Tænia Solium, Tænia Mediocanellata, Bothriocephalus Latus, Tænia Echinococcus* (*Hydatids*)—Symptoms and Treatment of Tapeworm—The Prevention of Tapeworm;
- *Round Worms* (*Common Round Worm, Ascaris Lumbricoides*), *Thread Worm* (*Oxyuris Vermicularis*), *Whip Worm* (*Tricocephalus Dispar*), *Trichina Spiralis* (*Trichinosis*); Symptoms and Treatment of Round Worms.

Diseases of the Abdominal Cavity and Walls:
- *Inflammation* (*Peritonitis*), *Dropsy* (*Ascites*), *Rupture* (*Hernia*).

Diseases of the Rectum and Anus:
- *Fissures and Ulcers* of the Anus and Rectum, &c.; *Piles; Prolapse* (falling down); *Fistula;*
- *Itching of the Anus* (*Pruritus*); *Foreign Bodies and Tumours.*

Diseases of the Liver:
- *Congestion, Inflammation*, and *Abscess of the Liver; Cirrhosis* or *Thickening* of the Liver (Hob-nailed, or Drunkard's Liver);
- *Inflammation and Obstruction of Bile Ducts;*
- *Biliousness, Jaundice* (*Icterus*), *Absence of Bile* (*Acholia*), and *Gall Stones;*
- *Degenerations of the Liver*—Fatty and Waxy Degeneration;
- *Tumours of the Liver.*

Diseases of the Pancreas:
- *Inflammation*, &c.

Diseases of the digestive system are very numerous and important. In some respects, indeed, they are the most important class of diseases that fall to be considered in a work of this kind. In a sense the digestive organs are more open to the attack of disease than any others. In normal circumstances a person's lungs, for example, are well guarded; his heart is beyond his control, and cannot be directly affected by him; but his stomach is daily at his mercy, is daily the victim of his whim, his taste, or his passion, has no fixed periods of work and repose, like lungs and heart, but is at one time overburdened, and at another perhaps in a state of inactivity for many hours. Everyone knows the effects of overwork on the body, or of overwork on a particular part of the body—an arm, for instance. We all know what is the feeling of a tired arm, or a wearied set of muscles, and we all interpret the feeling properly enough, and have usually sufficient sense to give the jaded arm or muscles rest in order to recovery. But we do not speak of a wearied stomach; and multitudes of people do not understand what that sensation is, not because they never experience it, but because they never rightly interpret it. Yet a stomach tired with overwork, and giving rise to feelings which are its loud calls for rest, is probably as common a sensation as a fatigued muscle. Its calls, however, are not properly understood, and instead of repose it more often receives excitement. A tired stomach is as unfit for the full discharge of its proper work as a wearied arm is unfit for its labour. Its performance will be incomplete. The very first part of the process of preparing nourishment for all the organs of the body is improperly carried out, and the effects of that first failure it is difficult fully to appreciate. If every organ and tissue of the body seek their nourishment from the blood, and if the quality and quantity of the blood are mainly dependent upon material obtained from the food, which has undergone a process of preparation in the stomach and intestine, it is evident how the fitness of the blood to nourish the body necessitates the integrity of the digestive process.

Again, the digestive system is one of the main gateways of disease. We all know how speedily poisons may destroy life. But most poisons are harmless when applied to the outside of the body. It is only after they gain entrance to the body, chiefly after they gain access to the current of blood and are able to attack directly one organ or another, that their effects can be obtained. Their chief way of gaining entrance is by the stomach, though it is not their only way, as we shall see when we come to consider poisons. Now this is true not only of those things that everyone regards as poisons. The old proverb, "One man's meat is another man's poison," is a very true one, and points to the fact that what one man may eat and drink with satisfaction and benefit another man may not eat or drink without serious disturbance. This may happen, not because of the nature of the substance, but because of the peculiarity of the individual. There is, therefore, a perpetual possibility that a person may take in his food or his drink something that is, from its very nature, injurious to his system; and also that he may introduce something into his stomach which is not of itself hurtful, but which, owing to his peculiarity, may become the cause of disorder. Thus the digestive system is a gateway of disease that stands continually open.

It is advisable to recall here the distinction that has been explained between organic and functional disease. An organ may have some defect of structure which makes it organically diseased, but the performance of its duties may not be affected in proportion to the extent of the organic disease; while an organ may not discharge its business properly though there be no departure from the normal in its structure. In the latter case it is affected with a functional disease. So we shall see, as we go along, that some diseases of the digestive system particularly affect structure—inflammation, ulceration, cancer, &c.; while it may be the seat of severe functional disease—indigestion, for example—though its structure is not sensibly affected.

It is strongly urged that anyone consulting this section, specially in reference to such disorders as are classed under the heading of indigestion, should carefully read the description of the digestive process given in the preceding pages. Disorders of digestion cannot be understood without a previous acquaintance with the physiology of the digestive process.

DISEASES OF THE LIP, MOUTH, TEETH, &c.

Inflammation of the Mouth, accompanied by the formation of ulcers on the tongue and inside of the cheek, and decay of the gums, is specially a disease of children. (Refer to DISEASES OF CHILDREN.)

Thrush or Aphthæ (*Sprue*), in which small white patches are formed over the tongue and lining membrane of the mouth, is also specially a disease of childhood.

For **Hare-lip** and **Cleft-palate** see also DISEASES OF CHILDREN.

Ulcers of the Lips occasionally form on the mucous membrane lining the inside of the lips. The ulcers are of a small circular or oval shape, of an ashen-gray colour, and depressed beneath the surface. They are painful, particularly when chewing is performed. They may be caused by the irritation of a bad tooth, and are frequently the accompaniment of digestive disorders.

Their treatment consists in removing any cause that may exist in the form of bad teeth, and in the use of simple opening medicine, such as seidlitz-powder, citrated magnesia, &c. The pain is rapidly relieved and the ulcer healed by applying with the finger, or a camel-hair pencil, some of the tincture of myrrh and borax, or a solution of chlorate of potash (15 grains to the ounce of water) with a small quantity of added glycerine. A solution of the same strength of borax and glycerine, or borax and honey, is also useful.

Cracks and Fissures of the Lips should be treated with glycerine or vaseline, the lip being kept constantly soft and moist.

A Warty Growth, quite white and mushroom-like, is often seen on the lips. It should be touched with glacial acetic acid once or twice daily, and will soon disappear. Care must be taken not to permit the acid to touch the rest of the lip. It is best applied by a small piece of wood—the end of a match, for example—which is moistened with the acid.

Cancer of the Lip.—The lower lip is a favourite seat of a particular form of cancer known as epithelioma, or skin cancer. It is so called because it consists of a tumour due to an enormous increase of cells similar to the epithelial that form the outermost layer of the skin. The disease is commoner in men than in women, and specially in men of the labouring classes. It seems to be caused often by long-continued irritation. Thus it is frequently found that a man with cancer of the lip is in the habit of smoking a short juicy clay pipe, and that the tumour is on that side at which the pipe is held. But other constant irritations seem capable of causing it.

Symptoms.—It begins sometimes as a crack or fissure, which is annoying because of its refusal to heal, sometimes as a sort of wart, at other times as a hardening and thickening in the skin. In this form it may continue for a long time. Sooner or later the skin breaks and an ulcer is formed. The ulcer has a hard base and edge, and gives out a thin, foul discharge. If not removed it is bound to spread, to grow deeper and broader, and to affect the glands and other parts.

The **treatment** is without doubt removal by the knife, and the sooner it is removed the better. If once the glands have become affected the case is serious. If, therefore, anyone has a deep hard ulcer of the lip, which stubbornly refuses to heal under ordinary remedies, and especially if it is on that part where the mucous membrane of the lip joins the skin, a regular surgeon should, without delay, be consulted.

Inflammation of the Tongue accompanies the affection called **salivation or ptyalism,** in which the chief feature is a continuous flow of badly-smelling saliva, which constantly dribbles from the mouth. The salivary glands are swollen and painful, and the tongue, gums, and other parts of the mouth share in the inflammation and swelling. The smell from the mouth is very foul. The excessive salivation is frequently due to mercury, not necessarily to its excessive use, for some people are peculiarly liable to its influence, and with them even a single grain of calomel may produce the effects. In such a case the treatment consists in the use of mouth-washes of chlorate of potash, or chlorinated soda (see PRESCRIPTIONS—GARGLES, &c.), in the use of opening medicine, and 3-grain doses of iodide of potassium given in water thrice daily.

Inflammation of the tongue, with great swelling, pain, and inability to speak or swallow, may, however, occur alone. It is to be treated with brisk doses of opening medicine of ordinary salts, or seidlitz salts. Gargles similar to those prescribed above are also to be used. Large hot applications under the chin will help to relieve the pain and the swelling, and leeches may be necessary. An abscess may be formed, which will, of course, require opening. Sometimes such inflammation will cause the tongue to attain a size greater than the mouth can contain, so that it is protruded outwards.

Ulcers of the tongue are frequent, and are commonest at the sides from friction with a decayed tooth. The tooth should be removed, and the treatment advised for ulcers of the lip adopted.

Cracked Tongue exhibits a series of irregular furrows, often of some depth, running over the surface of the tongue. They are very painful, and interfere with speaking and eating.

Any digestive disorder which may be the cause should be properly treated, and the borax-and-glycerine wash mentioned above used freely.

Cancer may have its seat in the tongue. It is usually of a sort akin to that of the lip, presents similar characters, and demands similar treatment—removal by operation.

Tumour under the Tongue.—**Ranula** is the name applied to a form of tumour under the tongue, which consists of a sac filled with a gelatinous sort of fluid. The tumour may be so large as to affect speech and even push the tongue upwards or to the side. It is associated with the duct of the gland under the tongue, and is supposed to be due, sometimes, to the blocking of that canal. A surgeon should be consulted for its removal.

Warty Growths are also formed on the tongue. The acetic acid, as used for similar growths on the lips, may be tried.

Injury to the Tongue is frequently caused by accidental bites. The teeth may even be driven deeply into the tongue by a fall. It is best to leave the tongue alone in such a case, and to permit nature to heal the wound. Bleeding may be controlled by pressure over the part.

Inflammation of the Gums is common in children during the period of teething. It is considered in the section on DISEASES OF CHILDREN. Simple inflammation may occur in grown-up people. The part of the gum affected is dark-red, congested, and very tender. A brisk purge and hot application to the part will relieve; but often nothing is equal to free lancing, which permits the excess of blood to escape, and thus immediately gives relief. A commoner thing in elderly people is that condition in which the gums become spongy, soft, constantly painful, and liable to bleed at the slightest touch. They separate from the teeth, which become loose in consequence.

In a very large number of cases the inflamed and spongy gums are produced by the irritation of decaying stumps or small pieces of rotting teeth, or the tartar that forms on the teeth in elderly people. With their removal the inflammation disappears.

The **treatment** should be directed as much to the general bodily condition as to the condition of the gums. Sluggish action of the bowels and liver will maintain the bad state of the mouth. Free use of purgative medicines should therefore be made, to unload the digestive organs, and astringent washes and gargles used for the mouth, those of chlorate of potash, borax, or tannic acid being best, while a tooth-brush should be used daily with camphorated tooth-powder, the gums being well rubbed.

Gum-boil is usually due to the irritation of a decayed tooth. Beginning in the socket of the tooth it works its way outwards. The more deep-seated it is, and the greater difficulty it has in coming to the surface, the more intense will be the pain. Usually it is evident from the swelling of the gum that a gum-boil is being produced. Sometimes when it is deep seated, at the end of the fang of the tooth, there is no apparent swelling. In such a case, that suppuration is going on at the end of the tooth is ascertained by firmly pressing the tooth down into its socket. This procedure will give rise to severe pain if an abscess be forming at the root of the tooth, and will thus indicate the seat of mischief.

The **treatment** consists in the use of hot applications, in the removal of the decayed tooth, and in letting out the matter where it comes to the surface. If the tooth that is the source of irritation be not removed, or otherwise properly treated, the gum-boil is liable to recur again and again.

Toothache is due to decay of the substance of a tooth—**dental caries**, as it is called. It has been pointed out (p. 196) that the crown of a tooth consists of a cap of very hard substance called enamel, covering the dentine, which forms the main bulk of the tooth, and is not so hard as the enamel. Now the enamel is a very resisting substance, though it is brittle, and so long as it is perfect the tooth is not liable to the carious disease. Sometimes, however, the enamel is imperfect, and the dentine becomes exposed, and the process of softening and breaking down begins. The dentine may be attacked through so small an opening in the enamel that the tooth appears to be perfectly sound, while it may be completely decaying within. The decay seems to be due, in the first instance, to a chemical process, whereby the salts of the enamel and dentine are removed by acids produced in the mouth. The acids are not produced by the glands of the mouth, nor are they normal constituents of any of the fluids of the mouth. They are produced by the decomposition of particles of food that lurk in recesses about the teeth. Certain parts of the teeth more easily retain portions of food, which may in time, owing to decomposition, obtain the power of attacking them; notably in the furrows between the cusps or points on the surface of the large grinding teeth will food remain, as well as round the neck, and between the teeth. Again, some parts of the teeth are more exposed to attack than others, any parts, for example, from which the enamel has been worn away. Teeth which are too much crowded, therefore, will have more surfaces than usual pressed upon and rubbed, and so overcrowding is a frequent cause of bad teeth. It ought, also, to be remembered that the teeth share in general states of the body, and that a long period of ill-health may, indeed quite commonly does, very materially affect their resisting power and make them easy victims to decay. A person often bears the marks of a long illness in irregularities of the teeth. When the dentine has become exposed it begins to soften, to become more or less discoloured, and to break down. As the affection passes inwards the pulp is reached, the intimation of which is that toothache begins. At first it may be that the tooth is affected only now and again, when hot or cold things are taken into the mouth. The pulp contains blood-vessels and fine filaments of nerves, and when the irritation reaches it inflammation will readily arise, of which sensitiveness and aching are the signs. Suppuration of the pulp may arise, and if the matter cannot escape above, it forces its way down the fang, at the end of which, in the socket of the tooth, the matter collects, forming a gum-boil. The inflammation and swelling also loosen the tooth, and raise it to some extent in its socket.

The treatment of toothache, short of extraction of the tooth, is seldom very satisfactory if the pulp has actually been attacked. One of the best applications, however, is carbolic acid. But it is difficult for anyone, not accustomed, to apply it properly, and it is liable to be so clumsily employed as to burn the mouth and tongue very severely. A small camel-hair pencil should be used, the hairs being cut rather short. It is moistened with the acid, care being taken that there is not enough on the brush to run, and the cavity of the tooth is to be well cleaned out by pushing the brush well into it and turning it about. The brush is to be removed, cleaned, and reapplied with some fresh acid, the person being permitted to wash the mouth with warm water after each application, to remove excess of acid. When the pain has been soothed, a small piece of cotton, moistened with carbolic acid, is to be pushed well down into the tooth, and it may be covered over with a piece of cotton soaked in a solution of gum mastic or benzoin. Creasote may be used in the same way. If a tooth be simply sensitive from exposure of the dentine, a mouth-wash of two teaspoonfuls of bicarbonate of soda to a glass of water is recommended to be used several times a day to allay the pain.

Neuralgia is often mistaken for toothache. The main distinction is that neuralgia comes and goes, and specially that it very often returns at the same hour each day. Pregnant women are specially liable to this form of pain in the teeth. Teeth are often extracted in the hope of relieving pain, when it is neuralgia that is the affection and not toothache; and the extraction gives, at best, only temporary relief. Yet many people are reduced to such desperation by the constantly recurring pain that they will sacrifice one tooth after another, and often several at once. Neuralgic toothache is best treated by the person taking some ordinary opening medicine to begin with, and then pursuing for some time a system of tonic treatment with quinine and iron, or the phosphorus pill recommended on p. 169, and at the times of recurrence of the pain the quinine and salicylate powders recommended on p. 170 for neuralgic headache.

Stopping Decayed Teeth.—Much can now be done in the way of arresting the decay of teeth, and in repairing those already decayed. This is effected by scraping away the decayed and decaying parts of the tooth and filling up the cavity with some kind of cement, or with gold or an amalgam. The kind of filling of which cement may be taken as an example is valuable, because it does not conduct heat or cold so much as a metal. A tooth, formerly sensitive to hot or cold liquids taken into the mouth, will be protected by such a filling. On the other hand, a metallic filling, which readily conducts heat, would not render such a tooth less, but rather more, sensitive. The want of permanency of cement is its disadvantage, and the metallic substance is in this respect superior to it. So that the nature of the material with which a tooth should be stopped is largely dependent upon the tooth itself.

The best time for stopping teeth is before the pulp has been in any way attacked. In fact, the sooner any decay present in a tooth is discovered the better, and the sooner, after the discovery, steps are taken to arrest the decay, the more likely is a successful result attainable. For if the tooth be attended to early, a competent dentist may restore it to an almost perfectly satisfactory condition. There is, therefore, a very sufficient reason why those who can afford it should consult a dentist periodically, to have their teeth inspected and, if need be, repaired. It should always be remembered that it is far preferable to have the natural teeth stopped, if possible, than to have artificial teeth, which are a frequent source of annoyance.

Anyone who wears plates of artificial teeth should always remove them at night, and should never go to sleep with them in the mouth; they are liable to slip off and pass back into the throat. Before a plate is fitted to either the upper or lower jaw, all stumps should be removed, and all roots as well, unless they are filled with some preservative filling. The decay which occurs in roots covered by a plate is of a peculiarly poisonous kind, and sooner or later produces serious digestive and blood disorders.

Bleeding after Extraction of teeth is sometimes troublesome, and even dangerous. The cavity left by the removal of the tooth should be well cleaned out. This may be done by means of a camel-hair pencil moistened with tincture of steel, which tends to produce contraction of the blood-vessels. A small piece of cotton steeped in the tincture is then pushed hard down into the bottom of the cavity, and one small piece of cotton after another is packed tightly in after it, till the cavity is filled up to the level of the top of the gum. A little pad of lint may then be placed on the top in such a way that the opposing teeth will press it firmly into the hollow when the mouth is shut. If the bleeding is not so severe as to require all this, cleaning out the cavity and touching it with tincture of steel, and then the sucking of ice for a short time, may arrest it, or merely placing a small roll of lint or wool over the cavity and shutting down the upper jaw on it, so that it is pressed on to the bleeding part.

Tartar, or salivary calculus, is a deposit of earthy material on the teeth at the margins of the gums. The deposit is separated from the saliva, and is mixed with remains of food. It is found in greatest abundance on the front teeth of the lower jaw and the grinding-teeth of the upper jaw, because they are nearest the openings of the ducts from the salivary glands. It is an irritating substance, produces congestion and softening of the gums, which may lead to ulceration, separation of the gums from the teeth, and loosening of the latter in their sockets. If tartar has accumulated, it should be removed by a sharp instrument if necessary; but if proper care is taken of the teeth it will not be permitted to accumulate, and its evils will thus be avoided.

The Care of the Teeth and Mouth.—It has been seen that the common cause of decaying teeth and toothache is the product of particles of food permitted to remain and decompose in the recesses of the teeth. The best preventive of toothache is, therefore, cleanliness. The teeth ought to be brushed regularly once each day with a tooth-brush and tooth-powder. One of the best of powders is the camphorated chalk, to be obtained from any chemist. It ought not to contain any gritty material that could scratch the tooth and injure the enamel, and should be very fine and soft. For the same reason the brush should be soft, and the hairs not too closely set. The habit of using a tooth-brush ought to be begun early, and regularly persisted in. To remove food from between the teeth after meals a *quill* toothpick should be employed, and never a pin or other similar instrument, which is likely to injure the enamel. For the benefit of the gums and other parts of the mouth, a mouth-wash ought also to be constantly in use. One of the best is made by taking ½ ounce of pure carbolic acid, the same quantity of the compound tincture of myrrh and borax, 1 ounce of glycerine, and 3 ounces of water. This is to be well mixed and kept in a bottle. When required, half a small teaspoonful is diluted with half a tumbler of water, with which the mouth is well cleansed and the throat gargled. Among other things this wash is very useful for removing the bad smell of the breath, whether it arises from bad teeth, spongy ulcerated gums, or from smoking, &c.

Inflammation of the Salivary Glands (*Parotitis*, *Mumps*, (Scotch) *Branks*).—The salivary glands, and especially the parotid gland which lies in front of the ear (p. 197), are liable to an inflammatory affection, which, in this country, is popularly called the mumps.

The **symptoms** of the disease are that the gland swells, becomes hot, red, and painful. The swelling extends down towards the jaw and round the neck, so that the face becomes disfigured owing to its increased breadth by the swelling. One side is generally affected after the other. The swelling causes some pain, and difficulty in chewing and swallowing. Accompanying the disease are fever, white tongue, and headache, and perhaps pains in the limbs. The swelling goes on increasing for three or four days. In about a week, at the most, it begins to subside, and the tenderness to diminish, until, usually at the end of ten days or a fortnight, it has almost if not quite disappeared. A remarkable thing connected with the disease is that in the female it is often accompanied by swelling of the breast, and in the male of the testicle, which, besides swelling, becomes painful, and continues so for a few days.

The disease occurs epidemically, and is very infectious. It almost never happens that the same person is attacked twice. After the person has become infected, the disease takes nearly three weeks to show itself. It is specially a disease of childhood; and if it appears in a school or a family, several are liable to be attacked, either together or one after the other.

The **treatment** is very simple. The child is to be confined to one room and kept quiet. Gentle opening medicine—castor-oil, syrup of senna, or such simple medicine should be given at the outset. The pain will be completely relieved by a few doses of the following powder:—

Bromide of potassium,.........	5 grains.
Antipyrin,.........................	4 ,,
Phenacetin,.......................	2 ,,
Citrate of Caffein,............	½ grain.

This powder should be thoroughly mixed in a wine-glassful of water. To a child of eight to ten years a second might be given in four hours, and a third six hours after the second, but a grown-up person could take one every half-hour till four had been taken, and thereafter every two hours till the pain had gone. If this powder is not obtainable, hot applications to the inflamed glands are very soothing, hot cloths, bags of warm bran, or ordinary poultices. Light food only is to be allowed—milk, bread and milk, &c. Chewing should be entirely avoided till all swelling has disappeared. If the breast swells, hot applications must be used, and the same to the testicle, combined with a suspensory bandage to support the part.

Swelling of Glands about the neck, at the angle of the jaw below the ear, or under the jaw, must not be mistaken for mumps just described. The glands involved in mumps are the salivary glands, the glands referred to here are lymphatic glands, and their positions are marked in Fig. 128, the affection being described on p. 284. The swelling is referred to here because the commonest cause of swellings about the neck or jaw is decaying teeth and inflammation and suppuration of the tonsils, which have just been described. If attention be not paid in time to these swellings, they will break down into matter and burst, leaving most unsightly scars.

Treatment should consist first of all in hunting for the possible cause of the swelling in decaying teeth, large and irritated tonsils, which should be thoroughly dealt with. A paint is made of extract of belladonna with 12 grains of iodine to each ounce of extract, the iodine being first dissolved by the help of 10 grains of iodide of potassium in ¼ ounce glycerine, and then rubbed up with the extract. This is painted thickly over the part and covered with a thick layer of prepared wool, which is pressed firmly over the part by a well-applied gauze bandage. The bandage should be removed and the paint gently washed off every third day to make sure that the swelling is not breaking down, or the skin becoming too much acted on by the iodine. At the same time syrup iodide of iron should be given in ¼ to ½ tea-spoonful doses in water thrice daily. If matter forms, an incision should be made while the skin is yet sound, and the sac of matter bodily removed if possible. For if a surgeon has the chance of doing this in time before the matter has infected the surrounding parts, the wound may heal at once, the faintest line only being left to mark its site.

DISEASES OF THE THROAT, TONSILS, AND GULLET.

Catarrh is the proper medical term for the disease commonly called "cold," or "cold-in-the-head." It is sometimes, though improperly, called **influenza**, for true influenza is an epidemic disease. **Weed** is the term applied to catarrh by the people. Its cause is exposure to cold, either by sitting in a draught, by too rapid cooling down after some severe exertion producing profuse perspiration, or by a wetting, and in various other ways. The term catarrh is derived from two Greek words, *kata*, down, and *reo*, I flow, a flowing down, and is so called because of the increased secretion—defluxion—that pours out from the inflamed mucous membrane of the nose, throat, &c., specially during the early stage of the disease. It is a disease to which all are more or less liable; and one attack never gives security against a second. Some people, indeed, seem very prone to it, and are very frequently attacked by it. It is not in itself a serious disease, though it is one very inconvenient, and producing great discomfort. Yet it must always be promptly and carefully attended to, since it is capable of leading on to much more serious diseases, of which bronchitis is the most common. If not properly attended to, it may be but the first step of a long period of illness, in which the lungs may become very seriously affected.

The **symptoms** of catarrh often begin with a sense of chilliness and shivering. There is fever, sometimes slight, sometimes severe, and a sense of weariness, with pains in the limbs and back. Sometimes the person feels as if he had been beaten or bruised all over. The skin is hot and dry, the pulse is quick, there are thirst, dryness of the tongue, and loss of appetite. The urine is less than usual, of a dark colour, and there falls a copious brownish deposit on cooling; and the bowels are constipated. Apart from these general symptoms there are others, affecting particularly the nose, throat, and chest. Commonly the nose is first affected. It is dry and stopped, and the person has to breathe through the mouth. The stuffiness is due to swelling of the lining membrane, the blood-vessels of which are more filled with blood than usual; and the membrane is thus red and irritable. The cold air acting on the irritable membrane causes fits of sneezing. The membrane lining the nose is continuous with that of the eyelids, which also partake of the increased blood supply, and are consequently red and watery-looking. In a short time the dryness of the nostril yields to a flow of thin, irritating fluid, requiring constant use of a handkerchief. The irritating character of the discharge is seen by the redness and tenderness which it produces on the lip and parts over which it flows. Accompanying these symptoms are loss of the sense of smell, a feeling of fulness about the bridge of the nose, and browache. This group of symptoms constitutes "cold-in-the-head," or **coryza**. The copious discharge from the nostrils does not continue long, and is succeeded by a secretion of thick matter, which indicates the diminution of the inflammation of the membrane of the nose, also signified by the nostrils becoming less blocked.

We have said that the mucous membrane lining the nose is continuous with that lining the eyelids (through the tear-canal; see section on the Eyes), and that this explains the participation of the eyes in the inflammatory process. But the same membrane is also continuous with that of the throat (see Fig. 101, p. 195); and so, as one would expect, the inflammation is not confined to the nostril, but travels backwards and downwards to the throat.

The symptoms associated with the throat are similar to those of the nostril. The mucous membrane becomes swollen and intensely red. The throat is also painful. The first sign of the throat being inflamed is frequently that of a tingling, pricking sensation; and when, in consequence, the person looks at his throat in a glass, the unnatural redness of tonsils and fauces is perceived, at first, perhaps, only on one side, but ultimately on both sides. The tonsils frequently swell considerably, so that swallowing is painful and difficult; and the uvula may be much enlarged and baggy, so as to reach down and touch the upper surface of the tongue. There is from the throat a secretion of thick mucus. The same circumstance that explains the extension of the disease from the nostrils explains its extension down the throat to the windpipe. This occasions a dry, harsh cough, which begins a day or two after the onset of the cold. If the windpipe be to any extent effected, the constant coughing induced, the pain over the chest so caused, the sense of oppression in the chest that arises, and hoarseness constitute that stage of the disease called "cold-in-the-chest." The popular phrase that the "cold goes down" into the chest is, therefore, quite a correct one. If the cold settles in the chest, then bronchitis and various other chest diseases may be induced, which will be considered in their proper place in the section on the Respiratory System. The stomach is also affected in the disorder, as the foul tongue indicates, it may be by the catarrh extending down the gullet to that organ. In still another direction the disease may spread, namely, up the tube—the Eustachian tube—leading from the throat to the middle ear. Swelling of the lining of that tube will block it, and so produce singing in the ears, and a temporary deafness, which are so annoying accompaniments of a common cold.

Such are the symptoms of a fully-developed catarrh. But it is not necessary that they should all be present in each case; in one person the force of the attack may expend itself on the nostrils, and be evidenced by the "running nose" and weeping eyes. In another person the fauces may specially suffer; and in another, hoarseness and cough may be the chief signs of it.

The disease should last only from two to four days.

The treatment is simple, but may be easily made sufficient to lessen the severity and duration of the attack, and to avoid consequences which are too apt to follow neglect of all treatment. Let the person be confined to the house, and, if not to bed, at least to one room, which ought to be maintained at an ordinary temperature. The disease may be arrested at the very onset by the person going straight to bed and having a dose of 10 grains of Dover's powder, along with 10 grains of antipyrin, followed in a short time by a warm drink of gruel or similar beverage. *This dose may be given only to an adult.* A second dose, but of half the amount, may be given two hours after the first, and, if necessary, another half four hours after the second dose. In the absence of Dover's powder 10 drops of laudanum, with 10 grains of antipyrin, may be given, followed by the hot drink, and every three hours thereafter half the same dose for four doses, *but not to children.* The writer has found a catarrh snuff of Dr. Ferrier very serviceable, *but only if used at the very beginning of the cold.* It is made of 60 grains of powdered gum arabic, 180 grains of subnitrate of bismuth, and 2 grains of morphia. The ingredients must be thoroughly mixed and kept in a small wide-mouthed glass bottle. A good-sized pinch should be taken on the nail of the little finger and drawn up each nostril, the nose having been gently blown previously. This, *if taken early*, often succeeds in arresting the disease, and it soothes the irritation of the nostrils. An extra pinch may be taken every second hour for several times. *The snuff must not be given to children.* The unfortunate thing connected with the use of Dover's powder, laudanum, or the snuff, is that many people take badly to any preparation of opium. While any of the substances mentioned usually relieves all the symptoms, in some cases the headache is increased, and sickness is produced. In such a case the irritability of the stomach will be diminished by sucking ice, which also will soothe the pain of the throat. On the morning following the use of any of these medicines a brisk purgative of seidlitz or other saline medicine should be given. If, after the acute attack has passed, the throat remains swollen, and secreting thick mucus, a gargle of alum, or chlorate of potash (of a strength of half to one tea-spoonful to a pint of water) may be used. If the nostrils remain swollen, and discharging yellowish matter, the same solution may be thrown gently into them by means of a syringe. The nose is often greatly relieved, and the symptoms even arrested, by the use of a nasal ointment made of white vaseline with 10 per cent menthol and 2 per cent cocaine. A portion of this, in bulk about the size of half of the half of a split pea, should be taken on the nail of the little finger and thrust up and drawn up each nostril.

Much may be done to prevent attacks of such a nature by the health being maintained by active exercise in the open air, and by the avoidance of over-heated rooms. A regular morning bath of cold water will also doubtless tend to diminish liability; but everyone does not take kindly to such an institution, and it would be a mistake to insist upon it, for so-called "hardening" purposes, if the person was manifestly none the better but rather the worse of it.

Inflammation of Tonsils (*Tonsillitis, Quinsy, Sore-Throat*).—Sore-throat is an occurrence of many diseases: scarlet fever, diphtheria, &c. In this form, however, it is not a mere symptom, as in the others, but the disease itself. It is usually the result of cold.

Symptoms.—The disease begins often by a shivering, or a sense of chilliness. The throat feels dry and painful, the pain being hot and stinging. At this stage the tonsils and neighbouring parts may be seen to be of a bright-red inflammatory colour. Soon swelling occurs, and the tonsil projects from the wall of the throat. Frequently one side is attacked first, and the other side a day or two later; but both may be attacked together. Owing to the tenderness and swelling, swallowing becomes difficult, and, if the case is severe, the swelling may become so great as almost quite to block the passage from the mouth into the pharynx. Speech becomes thick and difficult. The uvula becomes swollen, also, and red, hanging down often on to the back of the tongue, and provoking constant efforts to swallow or hawk up, from the feeling it produces of a foreign body being in the throat. The inflammation affects the glands of the mucous membrane, and causes an increased production of a thick mucus, which troubles the sufferer much, owing to the pain caused by efforts to get rid of it. The salivary glands may also be stimulated, by the increased circulation of blood in their neighbourhood, to excessive secretion,

Plate XV

NORMAL AND INFLAMED TONSILS

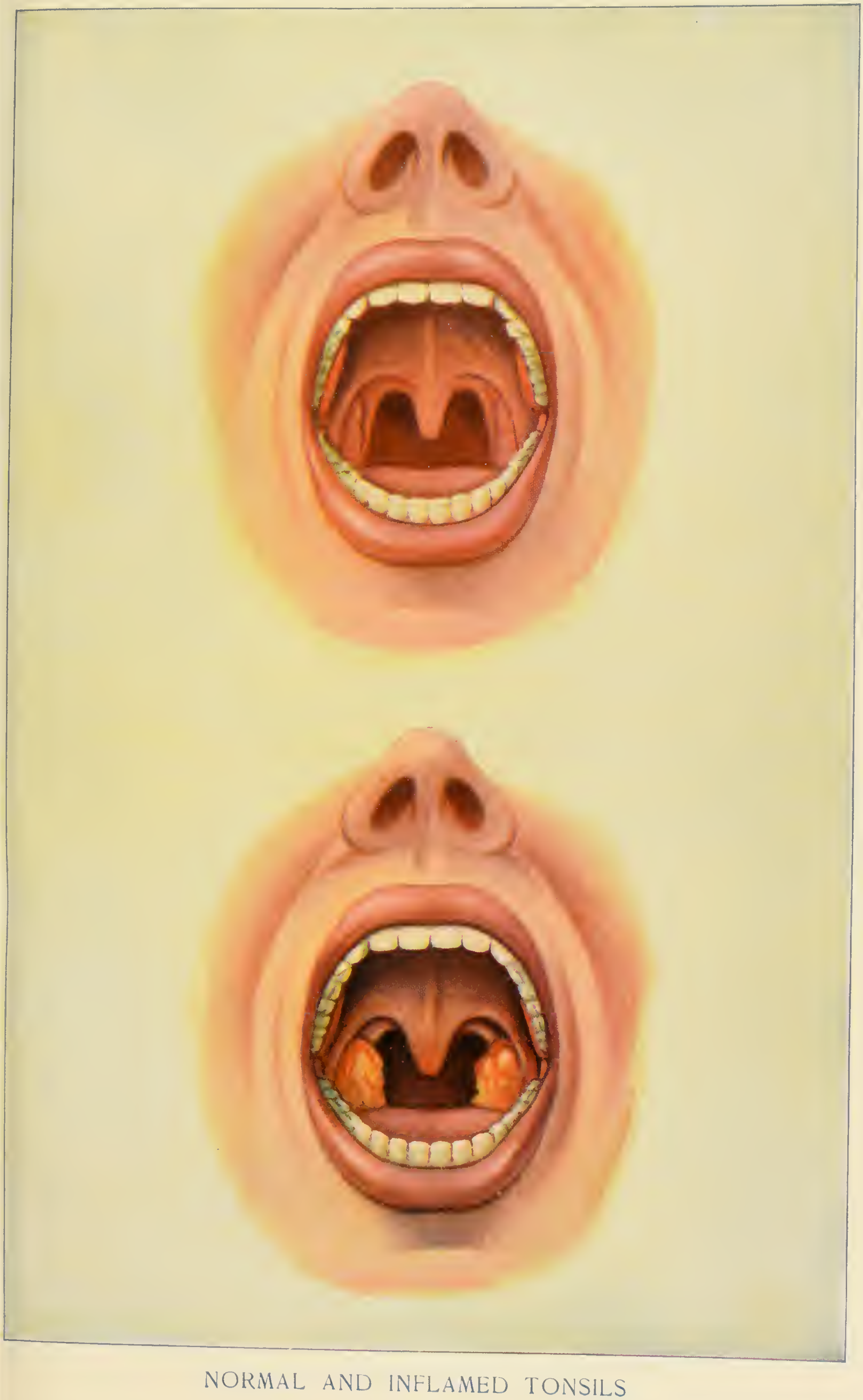
The upper figure shows the healthy cavity of the mouth.

The soft palate terminating in a double arch is well shown. From the top of the double arch drops the **uvula**, and behind this, in shadow, is seen the back wall of the **pharynx**.

The double arch with the uvula is called the **fauces**.

It will be noted that the arch on each side is not single, that the outside wall of each arch divides, at the top of the arch, into two, which slightly separate from one another, one being in front of the other at the level of the tongue. These are called the **pillars** of the **fauces**, each side having an anterior and a posterior pillar. Between the two pillars lies the **tonsil** on each side.

The lower figure shows the same parts, but here the tonsils are much swollen, projecting towards the middle line, covered with yellow pustules, their surfaces also—specially the right—ulcerated, the ulcers coated with yellow matter. The uvula is slightly swollen and its tip more deeply red than normal.



NORMAL AND INFLAMED TONSILS

and the extra quantity of saliva produced is allowed to dribble out of the mouth to save the pain efforts to swallow it would occasion. The swelling may also prevent the mouth being opened sufficiently to permit of the condition of the parts being seen, and the pain may pass up into the ear. With all this there are frequently smart fever, quick pulse, and severe headache. After three or four days the symptoms begin to subside, and may quickly pass completely away. In other cases the disease is prolonged owing to an abscess forming on one side or the other. If not opened, the abscess bursts into the mouth, affording immediate relief to all the symptoms. . A very short time after the matter is discharged, the person is usually able to swallow and to speak, though this may have been almost impossible to him before.

Sometimes the surface of the tonsils becomes dotted with whitish specks, which are formed by material from small glands, and which give the idea of ulceration taking place, and sometimes suggest diphtheria, to the ash-coloured spots of which, however, they have no resemblance. See Plate XV.

Traces of acute sore-throat are often left in permanently enlarged tonsils, elongated uvula, &c., results which will be discussed immediately.

Treatment.—At the outset a smart dose of opening medicine should be administered. Saline medicine is best, salts, seidlitz, or similar preparations. The person should remain in his room, and, indeed, in bed. To relieve the pain hot cloths or poultices may be applied outside, and the vapour of hot water, inhaled from a jug, will help to soothe. Sloppy food is taken most easily when the swelling is severe. Even liquids are often returned through the nostrils in such cases. As to medicines, it is doubtful how much benefit can be derived from them in ordinary cases. The guaiacum mixture of the British Pharmacopœia is strongly recommended by some. It may be taken in doses of 1 to 3 table-spoonfuls thrice daily. The powder may also be employed, 20 to 30 grains, suspended in solution of gum, every six hours. At the very beginning an emetic of 20 to 30 grains of powdered ipecacuanha will help to shorten the attack. As for gargles, the tannic acid or alum and catechu gargle (see PRESCRIPTIONS—GARGLES) will be found useful. The best way to use such applications, however, is in the form of a paint. A camel's-hair pencil should be dipped into the mixture, and, the mouth being opened as widely as possible, the affected parts are painted. This may be done often. The paint is most useful in mild cases. Anyone who has had an attack of sore-throat is always liable to another. He may know when it is coming on by a stinging in one tonsil, which is red and angry-looking. At this period if the paint be freely applied it may prevent any further advance. In very acute attacks, however, strongly astringent gargles are not advisable, and mild gargles, of warm water and milk, for example, are preferable, and still more the use of steam of hot water as mentioned.

If an abscess forms, the matter must escape, either by the abscess bursting or by it being opened. This latter should never be performed by any but a surgeon, as a large artery passes close to the tonsil, and runs the risk of being wounded by a careless or ignorant hand. Deaths from this cause have been recorded. Indeed in every acute case the care of a surgeon ought, wherever possible, to be secured.

Chronic Enlargement of the Tonsils is a common result of inflammation. The tonsils are permanently swollen and hard, and project sometimes so far as to interfere with speech and swallowing. This condition is specially annoying to public speakers, teachers, and singers. The voice is thick and easily fatigued, and the pitch of the singing voice may be seriously lowered. Breathing is noisy, especially during sleep. Partial deafness, from thickening of the membrane of the tube passing up to the ear, is not unusual. The paints recommended above may be applied in such a case. Touching with solid nitrate of silver is not advisable. It tends rather to maintain the irritation. If the enlargement is of any size, the only satisfactory treatment consists in the cutting out of the tonsils—not a painful operation—or in burning them with a hot iron—not painful either. Of course a surgeon only can perform such an operation. To weakly women and children cod-liver oil should be administered, and syrup iodide of iron in ½ to 1 tea-spoonful doses.

The uvula, like the tonsils, may be permanently enlarged and elongated. It may be so long as to rest on the tongue and occasion a tickling cough and tendency to vomit. A small piece should be snipped off with scissors.

Relaxed Throat, in which the mucous membrane of the pharynx is thickened and produces a troublesome thick secretion, is the result of frequent slight colds. It is best treated by painting the back and sides of the throat with tannin and glycerine, or iron and glycerine (see Prescriptions—Gargles, &c.), or by the alum or chlorate-of-potash gargle. The frequent use of a spray-producer, with solutions as recommended for clergyman's sore-throat (p. 390), is valuable. Doses, thrice daily, of the iron and chlorate-of-potash mixture (see Prescriptions) are also useful.

Adenoids.—Overgrowth of the same tissue as that which forms the tonsils may occur in other parts of the throat, for the tissue—lymphoid, lymphatic, or adenoid tissue—exists in and beneath the mucous membrane all along the alimentary tract, and overgrowth may occur anywhere, forming tiny little masses projecting from the mucous surface, or masses of considerable size. Such little overgrowths may often be seen on the back wall of the pharynx, forming irregularities on what ought to be its smooth surface. Such masses also occur in the pharynx above the level of the mouth about the level of the line from *b* in Fig. 101 (p. 195). If they occur to any size in this situation they will block the posterior opening of the nostril and render it impossible to breathe through the nose. A small growth will easily do this in children. Growths in this position are called **post-nasal adenoids**. The child cannot breathe through the nose and consequently keeps the mouth always open, and snores badly in sleep. An unintelligent dull expression of face usually accompanies the condition, and in many cases the general health is affected. The growths should be removed by operation.

Obstruction of the Gullet (*Stricture of Œsophagus*), altogether preventing, or rendering very difficult, the passage of food and drink to the stomach, may be due to actual constriction of the tube, to spasm, or to some foreign body blocking the way. The former is a condition that arises from inflammation, such as would very readily be produced by the attempt to swallow some corrosive poison, like oil of vitriol, &c. The inflammation causes thickening of the walls of the tube and consequent narrowing of the passage. The chief sign is difficulty in swallowing—**dysphagia**. Such stricture can sometimes be overcome by the repeated passing into the gullet of tubes for the purpose of stretching it, larger and larger tubes being used as the passage gets wider. The process of widening requires to be continued for many months.

Obstruction by spasm occurs with hysterical women. That the obstruction is not due to organic disease is evident from the fact that the difficulty of swallowing is only temporary. It must be treated as hysteria, to which refer.

Obstruction from a foreign body is not uncommon. All sorts of substances, that persons have been holding in the mouth, have been known to slip down into the gullet and block the way. False teeth have been known to do it. Consequently, every wearer of false teeth, that are not tightly fastened, should remove them before going to bed, as this accident has often happened during sleep. Practically a large mass of something that one may have been eating, or that may have accidentally slipped into the gullet without proper preparation, may act the part of an obstructing foreign body—a piece of an apple, for example. If the substance is actually in the gullet, and not simply in the pharynx at the entrance to the windpipe, immediate danger is not great. A sense of choking is, however, felt. Breathing may be quite unaffected, though fits of a suffocative cough may be produced. Spasm of the top of the windpipe, due to the irritation of the foreign body, may arise and threaten to suffocate. The body itself, if allowed to remain too long, may produce inflammation, ulceration, &c. A surgeon will decide whether an attempt is to be made to get the foreign body up or to push it down. If it is some soft substance which may become acted upon in the stomach and broken down, the tube of a stomach-pump, gently passed down to the place where the body is fixed, may succeed in pushing it onwards into the stomach. A mass of meat frequently "sticks in the throat," in the pharynx, where it can readily be removed by anyone who knows how. Let the person's head be supported by the left arm, let his mouth be opened by the handle of a spoon, or piece of wood, and then insert two fingers of the right hand into the mouth, pushing well to the side against the cheek. In this way the fingers will get well into the back of the throat, and one may be able to sweep out or hook up the obstructing mass. (Refer to Choking, under Accidents and Emergencies.)

DISEASES OF THE STOMACH.

In no department of medicine has greater progress been made in recent years than in that dealing with the stomach and bowels and their disorders. One result of this has been the production of huge volumes dealing with the subject at greater length than was formerly deemed needful for the whole of medicine, and the coinage of new words to describe the different varieties of disease now distinguished from one another. It would be quite useless to the ordinary reader to attempt in such a work as this to give even the briefest summary of the various disorders now described.

But in modern life no class of disease is more common or more on the increase, and there is great need for some general understanding of the subject.

Probably the most generally useful thing to do would be to explain what are the most common complaints connected with the stomach and bowels, to indicate how the modern physician proceeds to disentangle the complaint and learn its true character, and what the lines of treatment are which may be safely followed when a physician is not immediately at hand.

The complaints which, in the main, are associated in the public mind with disorder of stomach and bowels are some form or another of what is called indigestion or dyspepsia, constipation, and diarrhœa. Indigestion is usually referred to the stomach, constipation and diarrhœa to the bowels, so we shall associate what we have to say generally about stomach disorders with the word indigestion, and what we have to say about bowel disorders with the latter two disturbances, and, to simplify matters as far as possible, we shall discuss the disorders of stomach and bowels separately, though, as we shall see, they cannot often be separated in fact.

INDIGESTION OR DYSPEPSIA.

Dyspepsia is really a Greek word, and means bad digestion or difficult digestion. Indigestion means essentially the same thing. Now the words indigestion and dyspepsia refer to a condition of digestion, but that condition, bad or difficult digestion, may arise from a great multitude of causes. A person might suffer to-day from indigestion due to one cause, and might next week suffer again from indigestion from a cause so different as to make totally different treatment necessary, so that practically the two kinds of indigestion from which the person suffered might as well be considered two different diseases. The term indigestion, or the term dyspepsia, is thus used to cover a great number of diseases, which have this much, and perhaps only this, in common, that, owing to them, the food is not digested properly, in good time, or in comfort, and thus the main symptom arises from which the disease is named—some feeling of discomfort or actual pain connected with the presence of food in the stomach and bowels. Now it is essential that this should be properly understood. Very many people go to a doctor and announce to him that they are troubled with indigestion, and expect that, without more ado, he will order them a medicine that will remedy, without delay, their complaint. If he begins to make inquiries they answer impatiently: "Oh! I know very well what is wrong; it is just indigestion." In the same way people will turn up some dictionary of medicine and expect to find, under the head "Indigestion," some definite statement of treatment, which they have only implicitly to follow to be healed of their plague. Now such a view of the practice of medicine is an utterly mistaken one, and perhaps no disease shows better how mistaken it is than this one.

If reference be made to what has been detailed in pages 202 to 204 about the process of digestion, it will be noticed that there are various stages in the process; that one part of the process is performed in the mouth, another part in the stomach, a third part in the bowel; that the part performed in the mouth consists of (1) chewing and (2) the action of saliva on the starchy parts of the food, that in the stomach of (3) the action of gastric juice on albuminous parts of the food, that in the bowel of (4) the action of bile on fat, (5) the action of pancreatic juice on starch, albumin, and fat, and (6) the action of intestinal juice on various elements of the food. Now if any of these stages be imperfectly performed the whole process may be interfered with. In a piece of machinery the stiffness or irregularity of one small wheel may affect the working of the whole machine. No one would go to an engineer and say: "My engine works badly," or "My engine works with difficulty," and then expect to be told that the doing of some particular thing would make it right. Everyone knows the engineer would carefully examine till he found the exact place where the difficulty was, and then he would be in a position to say what would rectify it. Let us look at digestion in that light. If a person eats hurriedly, bolts his food, the first part of the process (chewing) is not properly performed. The result is that the food passes in masses into the stomach, and not broken down into very small pieces. The juice of the stomach gets acting only on the outside of the lumps of food, cannot get intimately mixed with it, cannot attack much at a time, and so the process is delayed; perhaps twice the time is occupied that there would have been if the person had taken the time and trouble properly to break down the food in the mouth before passing it on to the stomach. Suppose, however, the food is properly chewed, when it reaches the stomach, owing, perhaps, to the general health of the individual, sufficient gastric juice may not be poured out, or there may be always enough in quantity, but of poor quality. The juice may contain too much acid, or too little acid (p. 203), or may be not active enough with pepsin (p. 203), and in various other ways this stage of the process may be badly performed. Again, everything may be properly performed in the mouth and in the stomach; but, when the food reaches the small intestine, bile (p. 205) may be deficient owing to some fault of the liver, and the digestion of fat is interfered with; or the pancreatic juice (p. 204) may not rightly discharge its duty, and so digestion, which up to this point had gone on properly, is arrested, or in some way interfered with, and indigestion arises.

But this is not all. We know that engineers never build engines without having first decided what power they wish them to develop, at what speed they are to drive a boat or a train, what load they must be able to draw or to lift. It is but common sense to suppose that the human digestive apparatus is constructed, so to speak, for a certain power, that there is a certain quantity of material which suits it best, and that if it has to digest a quantity greatly in excess of that it will be overstrained or overloaded, and again indigestion may result. But it is equally common sense to suppose that, like machines invented by man, the digestive apparatus of a human being is adapted not only for a certain *quantity* of work, but also for a certain *kind* of work. The digestive apparatus of a worm is suited for the earthy food from which it draws its nourishment; and the apparatus of an ox is different, because its feeding is different. So there are certain kinds of food appropriate for man which his stomach and bowels, in their healthy condition, find natural to them, and certain other substances which they tend to reject as offensive to them.

Now, knowing these things, and many other circumstances have a similar bearing on the subject—knowing these things, is it not perfectly absurd to imagine that there can be one cure for indigestion, that the bare fact of a person suffering from indigestion is sufficient to indicate what treatment should be adopted? And is it not apparent that there may be as many ways of treatment as there are causes of the complaint, and that the only rational course to take is to ask what is the exact nature of the indigestion—does it arise from improper food, or from too much or too little food? is it due to too hurried eating? is the seat of indigestion in the stomach or in the bowels? and so on—and to let the treatment be guided by the results of such patient and careful inquiry? In short, is it not plain that the cure for the indigestion that afflicts a person whose bad teeth, or whose want of teeth, prevent him properly chewing his food is quite different from the treatment that will cure the indigestion of another whose teeth are perfect, and who chews his food well, but whose liver is sluggish, and so hinders the digestive process. Probably a slight stimulant to the slow liver, such as podophyllin, will help the latter individual, but is worse than useless to the former, whose indigestion will probably be driven away by a properly constructed set of artificial teeth.

The truth that these considerations ought to enforce is the necessity of determining, as accurately as possible, the stage of the digestive process that is interfered with, and the cause of the interference whose result is indigestion, before steps are taken to rectify what is wrong; and this truth, the need of discovering the cause, is as applicable to every other disease, and for similar reasons.

What the causes of indigestion are may now be briefly set down.

CAUSES OF INDIGESTION.

These may be divided into three classes: I. causes connected with the taking of food; II. causes connected with the process and organs of digestion; and III. causes connected with other organs, or with general conditions of the body.

I. Causes of Indigestion connected with Food.—Under the first class come many causes, some of which have been already incidentally noted. They are connected with the quantity of food, the quality of food, the length of time between meals, the length of time taken to meals.

Many people believe that almost everyone regularly eats more than is necessary. However that may be, it is certain that many people habitually over-eat, and that the fashionable style of dining tempts one to excess. For it is certain that when one partakes of a great variety of dishes, taking small quantities of each, the appetite is stimulated and maintained long past the time when satisfaction should have been felt. No absolute rule can be laid down except this, that the food that is necessary is just the quantity that will repair the waste of the body, and minister to any processes of growth that may be going on. Consequently, the hard-working man requires more than the man of idleness or ease. [In the chapters on FOOD details on this subject are entered into.] As an ordinary rule, satisfaction indicates that sufficient has been consumed.

As regards quality of food, enough for the present purpose has been said on pages 191 to 193. But it ought to be evident that tea and bread and butter, which seem to constitute the never-ending, unvarying diet of very many working-men, their wives, and children, is not a proper kind of diet. From a very considerable experience the writer can say that a very large proportion of diseases, beginning with indigestion and leading on to others, which are common among the working-classes is due to improper diet such as has been mentioned. The question has, of course, another side. The quality of food may be improper because it is too rich, or the food may be in itself very difficult of digestion. Thus foods rich in fats are likely to be indigestible, and the flesh of most shell-fish, lobster, &c., is difficult of digestion. A fish supper, in which oysters, lobsters, or crabs form a part, is not unlikely to lead to an uncomfortable night, and various digestive troubles—headache, loss of appetite, &c.—next day.

Many people are peculiar in having an aversion to certain ordinary articles of diet which agree well with others, but are certain to cause them trouble if taken. Tea, coffee, and alcohol are very apt to cause indigestion. Recent observations made by a French physiologist seem to show that the active principle of tea and coffee seriously delays the digestion of a meal with which it is given. At least the constant use of tea is bad, and specially if it is not freshly prepared, and if it is made very strong, as it frequently is. As to alcohol, no doubt small quantities used during a meal are in many cases a stimulant to sluggish digestion, but this fact is too often used as an excuse. It is the rule that the habitual use of alcohol, even in nips, leads to chronic catarrh of the stomach (p. 234), and to degenerative conditions of the liver, both extremely common causes of most intractable forms of indigestion. With many people tobacco directly provokes dyspepsia.

The times of meals are of very great importance. We have seen (p. 204) that after an ordinary meal the stomach will be occupied with its business for three to four hours. If only that interval elapses between several meals, the stomach has no rest between meals, but is no sooner done with digesting one than it is required to attack another. A short time should, therefore, be given between each meal, in which the stomach may renew its energies. Thus an interval of five or six hours should elapse between two meals. On the other hand, too long an interval is hurtful, and specially when, as is usual, the long fast is followed by a heavy meal. This is the error to which business men are liable. Nothing, or a quite insufficient quantity, is taken between the time when they breakfast and the time, usually late in the afternoon, when, business over, they return home. They then dine, and the temptation to forget the worries of business in the pleasures of eating and drinking is great, and leads them to prolong the time at table, and to stimulate the appetite with variety—with sauces, condiments, &c. Not only is this hurtful, from the excess to which it tends, but the stomach is probably not in a good condition for digesting even an ordinary meal, because of the degree of tiredness and of exhaustion, greater or less, that is the result of the day's work. Properly the business man should have a mid-day meal sufficient to maintain his energies, but light enough to ensure that it does not render him less fit for business, and when he returns home let him dine, but more sparingly, so that the remainder of the evening is not spent in a dull, half-asleep fashion, the result of a heavy meal, taken after an exhausting day of work without timely nourishment.

Again, the first class of causes of indigestion includes such errors as that of eating too hastily, taking food immediately after great exertion, or performing hard work, engaging in mental toil, or taking vigorous exercise, immediately after meals. As a cause of indigestion, also belonging to this class, must be included mental emotion, such as anxiety, alarm, or the emotions roused by the receipt of bad news, &c. In most cases, perhaps, the latter cannot be remedied; but, as regards the former, it should be a rule to rest a short time after hard work before partaking of food, and to occupy one's self with light employment for a short time, half an hour or an hour, after a full meal.

II. Causes of Indigestion connected with the Process and Organs of Digestion.—The second class of causes includes circumstances many of which have been already noticed. Imperfect chewing, either because the food is bolted, or because the teeth are bad or wanting, is one rather common cause of this class. Others are connected with the state of the stomach and the character of its digestive fluid. Thus, catarrh of the stomach, the result of a common cold, causes loss of appetite, &c., and most of the other diseases of the stomach act similarly. Acidity and heartburn, common symptoms of dyspepsia, arise from excess of acid, and are due to organic changes in the glands of the stomach; and so on. Similarly, conditions of the bowel, of the liver, and of the pancreas, all parts of the digestive apparatus, will act as causes of indigestion.

There is one circumstance which must not be overlooked. Undigestible material taken in with the food should pass through the bowel and be duly expelled. It has been explained also that certain waste substances, excreted by the liver, are passed into the bowel for expulsion. Now if for any reason these two kinds of waste substances, mixed together in the bowel, are not expelled so speedily as they ought to be, they are all the time undergoing putrefactive changes, and chemical changes of various kinds, by which in the fermenting mass there are produced foul gases and new substances poisonous to the body. If the material is not voided in proper time, the gas is liberated in the bowel, distending it and producing some of the more troublesome symptoms of indigestion.

But the chemical poisons (toxins they are called) are absorbed, and they act chiefly on the nervous system. Thus there are numerous disorders of the general system undoubtedly due to poisons manufactured in the body itself in this way, of which no symptom draws the slightest attention to stomach or bowels or suggests that the real source of the mischief is a fault in any of the processes associated with digestion. There is no longer any doubt, for instance, that some of the worst and most persistent forms of anæmia are due to intestinal toxins, to poisons, that is, produced in stomach or bowels by some flaw in the chemical part of the digestive process, or by delay in the evacuation of the waste from the bowel. The latter cause may exist, it should be observed, even when the bowels are moved daily, for it is clear that though the bowels may move every day, the whole of the material that should be expelled may not be so. Perhaps what is being daily expelled is only the excess, the overflow so to speak, what the bowel cannot hold. So that, while a person imagines, because he has a daily movement, that his bowels, at any rate, are all right, it may be that all the time the lower bowel is full, ejecting only what, with the constant additions it is receiving from above, it can no longer hold.

III. Causes of Indigestion connected with other Organs or General Conditions of Body.—The third class includes a great variety of conditions which affect the process of digestion directly or indirectly. Thus anæmia (bloodlessness) is in women a very common cause of dyspepsia, because the blood is not in proper condition to afford to the stomach the material for the formation of gastric juice in proper quantity and of proper quality, and because other parts of the digestive process are similarly affected. Diseases of the heart and lungs, by hindering the proper circulation of the blood, speedily affect the functions of the stomach and bowels. The nervous system regulates every function of the body, and consequently nervous diseases have some kind of dyspepsia as one of their symptoms. Properly speaking, in such cases the indigestion is not a disease in itself; it is only a symptom of a disease. In many, however, it may be so prominent a symptom as to blind to the fact that it is really only a sign of some other derangement which must be discovered.

It is worthy of special notice that in women dyspepsia is a very common result of tight lacing, because the pressure does not permit the healthy action of the liver, and induces other changes in the abdominal organs, of which the indigestion is one of the early expressions.

THE CONVICTION OF THE STOMACH AS THE SEAT OF INDIGESTION.

One may now ask—how is an outlet to be found from this maze of causes and effects? How is one to discover where the mischief begins and what causes it? For the only rational way out of the difficulties that beset the treatment of stomach disorders is to detect where and why the error begins.

If the cause of indigestion arises in the stomach, in how many different circumstances might it have origin? This can only be answered by a reference to what has been already said about the structure of the stomach and the functions it fulfils. If the complaint arises in the stomach it will be associated with food in some way, with

(1) the entrance of food,
(2) the stay of food,
(3) the exit of food.

Let us look at each of these for a moment. A well-known recipe connected with the making of hare-soup began: "First catch your hare." So in stomach disorders, before the stomach can be the seat of indigestion, food must gain entrance to it. Now and again one will meet with a case in which the sufferer complains of what he calls indigestion, but he goes on to say that food is no sooner swallowed than it is returned, and on close inquiry there arises reason to doubt whether much of the food really gains entrance to the stomach at all, and to surmise that the food, or at least a large portion of it, passes down only a certain distance, and is immediately returned. This occurs when the entrance to the stomach is blocked, as by a growth at the lower end of the gullet, or a narrowing there. In such cases it will usually be found that solids are returned at once, and that liquids go down more easily, specially if sipped slowly. A person who suffers from such a condition will probably lose strength and flesh very fast once the condition is fully established. Frequently the food may not be returned immediately, for the lower part of the gullet may dilate to form a kind of pouch in which the food may lie for a time.

But let us assume the food has gained entrance to the stomach, its proper digestion depends upon

(1) Mixture with a sufficient quantity of gastric juice containing hydrochloric acid and pepsin in certain proportions.
(2) Movement and mixture of the food by the action of the muscular layers of the stomach walls.
(3) Removal from time to time, by passing through the pylorus into the duodenum, of portions of food as they become reduced to fluid.
(4) There must be no admixture with the food, either before it enters the mouth or afterwards, of such substances as would tend to slow down or arrest the digestive process, or set going abnormal forms of fermentation. Certain drugs do this.
(5) Finally, there must be the complete emptying of the stomach, by the exit through the pylorus of the last remnants of the meal. The passage of fluid materials through the pylorus in any quantity probably begins from 1 hour to 1½ hour after a meal has been taken. In the case of a moderate, soft, and easily liquefied meal it has come to an end in about 3 hours; in the case of a large solid meal the stomach may not be empty for 6 or 7 hours, even in health.

These things being noted and understood, it is clear that indigestion will arise sooner or later under circumstances we may classify as follows:—

I. The quantity of gastric juice may be either (*a*) deficient in quantity, or (*b*) of seriously altered quality. The latter will happen if the juice contain too little acid or too much acid, or if the pepsin be inert or wanting.

In the one case, deficiency in quantity or in quality, the cause may be poverty of the blood supply to the stomach, or it may depend on actual changes which are slowly taking place in the glands of the stomach, by which they become atrophied or wasted, and unable to produce active gastric juice. In the other case, where the acid is in excess, this may be due to an almost exactly opposite condition of glands, in which overgrowth has occurred by excessive blood supply, engorgement of blood-vessels of the inner coat of the stomach. Such a condition is easily caused by too stimulating food-stuffs, or by excessively large meals, and abuse of stimulants and condiments. It will be clear, also, that the failure to produce proper gastric juice may be due to the effects of the constant irritation of an ulcer or to destruction of the glands by a new growth, such as cancer.

II. If the muscular wall of the stomach has so lost its tone that it is unable to keep hold of the food, so to speak, and maintain its churning movement, serious forms of indigestion will arise.

This lack of movement will become most significant when the time comes for the food to be propelled towards the pylorus and into the bowel. In marked degrees of it the stomach will cease to behave as an active organ, assisting digestion by its rhythmical action and finally emptying itself completely. It will behave as a lifeless sac into which food is tumbled, and which bulges out in proportion to the amount thrown in. In such a stomach digestion cannot go on normally, because it is necessary for normal digestion that digested portions be removed as soon after they have become fluid as possible, and this cannot be done because the propulsive movements of the stomach are deficient; and in the next place the stomach is never properly emptied.

III. The gastric juice may not be defective, and the muscular tone of the stomach may be sound to begin with, yet if the digested food cannot leave the stomach because the pylorus is narrowed or blocked, the whole digestive process is upset. A person may be born with a pylorus narrower than usual (this is discussed under diseases of children) and digestive troubles may be constant from birth up. But the narrowing may be brought on by ulceration, by the pressure or obstruction of a growth, or by inflammatory adhesions. Sooner or later, according to the degree of obstruction, the symptoms of such a condition become so marked and severe as to make it impossible to set them down as due to simple indigestion.

Broadly speaking, these three general conditions will include all cases of indigestion, from the simplest to the most severe, which have their origin within the stomach.

How then can the physician tell which is which? It is only necessary to indicate this in the briefest possible way.

The Methods of Detection of Stomach Disease in use by a Physician.—If the patient be laid upon his back, with his head and shoulders slightly raised, and the knees supported by a pillow under them, and the abdomen is then uncovered, an experienced eye will observe whether the shape of the abdomen is that of health, or whether it bulges unduly in the region of the stomach.

By laying his hand over this region, and moving his fingers in a trained way, according to the method called **palpation**, aided by tapping on a finger of the flat hand with a finger of the other, one may be able to make out whether the stomach occupies its usual position and is of the usual size. The fingers, pressed deeply, may be able to feel the presence of any unusual fulness or solidity, and detect whether there is any pain or tenderness, and the physician's knowledge of locality will enable him to surmise at what part of the stomach the pain, if any exist, is produced.

The Use of the Stomach-Tube to Determine Stomach Disease.—But modern methods have placed in the physician's hands far more valuable means of diagnosis. For he may pass into the stomach, through the mouth and gullet, a soft rubber tube by which some of the stomach contents may be removed. These contents are then filtered and submitted to a variety of tests to determine the amount and chemical nature of the acid present, and the degree of activity of the gastric juice as regards pepsin. The various reactions will also enable him to tell quite accurately whether abnormal substances are present, or whether any abnormal fermentation is going on. Some of the contents may also be submitted to microscopic examination, and the presence of organisms, as well as of matter,

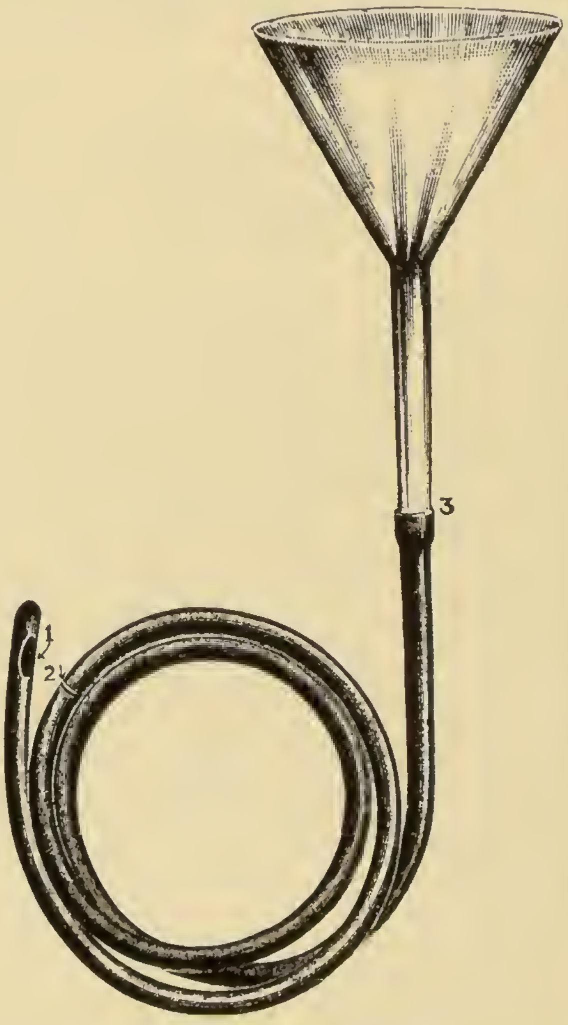


Fig. 110.—Stomach-Tube.

1, Opening at stomach end. 2, Mark on tube at 16 inches from stomach end. 3, Outer end of tube.

blood, &c., may thus be detected. Further, through the tube, water may be passed into the stomach, and the quantity it can hold be thus determined. The ordinary capacity is from 1½ to 2 pints. This water may then be siphoned off, and, the tube still remaining in position, the patient may be laid flat on a couch, an elastic ball may be attached to the outer end of the tube, and air may be pumped into the stomach till it is fully blown up, when its shape and size will be fully revealed by the way in which it bulges out the belly-wall.

Thus the physician will have determined, by combining these various methods:

(1) Whether the stomach is in its usual position,
(2) Whether it is of normal size and capacity,
(3) Whether the gastric juice is of healthy characters as to the activity of pepsin and the percentage of hydrochloric acid,
(4) Whether any abnormal acids are present,
(5) Whether unhealthy fermentation or putrefactive changes are occurring in it, and
(6) Whether organisms of disease exist in it.

How these facts, read in the light of his knowledge and experience, will enable him to come to an opinion as to the nature and cause of the digestive trouble will be understood when the significance is appreciated of some few facts that will now be stated.

In ulceration of the stomach the percentage of hydrochloric acid is usually much increased, while in cancer of the stomach hydrochloric acid is much diminished, and in advanced cases absent.

In catarrhal states of the stomach, while acid and pepsin are diminished, there is much mucus present in the contents of the stomach.

In indigestion due to poorness of gastric juice, atonic dyspepsia as it is called, while the contents of the stomach show deficient acid and pepsin, excess of mucus does not exist, and the withdrawn contents show little change.

In dilated stomach, instead of 1½ to 2 pints, he stomach will hold up to 4 pints and more.

In disorder of the stomach due to blocking of the outlet into the bowel, the stomach will be found to contain a large quantity of material, far more than the amount of one meal, and it will be fermenting and foul-smelling.

Incidentally the passage of the tube may reveal other things. For, if no preparation has been made, the size and alteration in the pieces of food will show whether the patient chews properly, and whether the digestion is active or feeble. The passage of the tube in morning, before any food has been taken, will show whether the stomach quite empties itself, or whether some food always remains unexpelled. In the latter case there is evidence of weak muscular power.

When the stomach-tube is used to withdraw contents for the determination of the chemical characters of the gastric juice, some preparation is made beforehand. A certain meal is prescribed, called a **test-meal**, which is taken when the stomach is quite empty, *e.g.* in the morning, and the tube is passed 1 to 2 hours later. To secure that the stomach is empty it is well first to pass the tube merely to wash out the stomach, the patient then takes the test-meal into the washed stomach, and this is withdrawn 1 to 2 hours later.

The usual test-meal or test-breakfast is that of Ewald, and consists of one Vienna roll and 15 ozs. of weak tea (three ordinary cups). It is withdrawn 1 hour after the beginning of the breakfast. A more substantial meal may be given, but it must be most thoroughly cut up and chewed, else the pieces will block the tube; and it is withdrawn 2 or 3 hours later, according to its size.

The use of the stomach-tube is attended by very little discomfort to the patient. On the first occasion there is often a little fuss, retching and gagging, by the patient. This is largely due to inexperience, to the patient holding the breath, and to nervousness. As a rule, the second time it is used, the tube passes without difficulty, and I have frequently had patients who passed the tube themselves on the third occasion with perfect ease. It is quite certain that if the tube can be passed by the physician it can be passed still more easily by the patient, as soon as he knows how and has had it done once or twice.

No patient whose physician proposes to use this method of investigation should hinder him, as it may be found that the passage of the tube and the washing out of the stomach may be the shortest and easiest road to recovery.

Spraying the throat with cocaine, smearing the tube with glycerine and so on, are frequently recommended as preliminaries. The tube, which must of course be of soft rubber, should shortly before use have been properly sterilized, by boiling for a minute in a 1-per-cent solution of bicarbonate of soda, and should then be immersed in warm water in a perfectly clean bowl or glass vessel. The author finds the simplest and easiest way is to lift the tube out of this warm water, and without any preliminary spraying or smearing to pass it straight down.

The patient should sit on a chair, a bucket between his knees, a rubber sheet round his neck and hanging down into the bucket. At his one side is a table with the vessel containing the tube, and the requisite jugs with water. The patient should tilt the head slightly up, and widely open the mouth, and the tube is passed straight to the back of the throat, and then gently but quickly pushed down, while the patient goes through the act of swallowing, but breathing freely. A spurt of air, and perhaps fluid, will indicate when the tube has passed into the stomach. This should occur when the length of tube passed, measuring from the teeth, is 16 inches, and at this part of the tube there should be a mark that cannot be rubbed out; a thread securely tied round the tube would do. The tube should be passed 2 inches farther, and if the stomach is in normal position, and of normal size, it should be possible now to empty out its contents by lowering the outer end, while the patient takes a deep breath, holds it, and then with his hands squeezes his stomach upwards, straining with his abdominal muscles at the same time. If it is necessary to push the tube materially farther, before the contents are got, this fact shows at once that the stomach is displaced downwards or dilated.

The tube should either be long enough, when it has reached the stomach, for its outer end to be lowered below the level of the stomach, or it is necessary to have an extra piece of rubber tubing ready with a glass or other connector to slip into the outer end of the stomach-tube. If so, this added piece must be quite tightly secured, lest the stomach-tube slip off and be swallowed. Some precaution should always be taken to prevent this, unlikely though it be. A piece of cord firmly secured to the tube, without compressing it, would do. But the author prefers to use tubes sufficiently long to obviate the need of any such precaution. A small funnel is easily fitted on to the outer end to permit of pouring water down the tube into the stomach. Fig. 111 illustrates the tube passed, and how the tube is raised to fill the stomach. To empty the stomach the funnel need only be lowered and inverted over the bucket.

How the Sufferer may be guided in deciding whether it is the Stomach that is at fault.—But this book is designed to be used by many far out of the reach of skilled advice. It would be absurd to suppose that by any amount of reading they could be taught to determine for themselves what it is so difficult often for the most skilful physician to decide after careful examination for them.

Nevertheless it is needful to try to give some guidance for such circumstances, and a long experience suggests to the writer that some of the gravest possible mistakes might thereby be avoided.

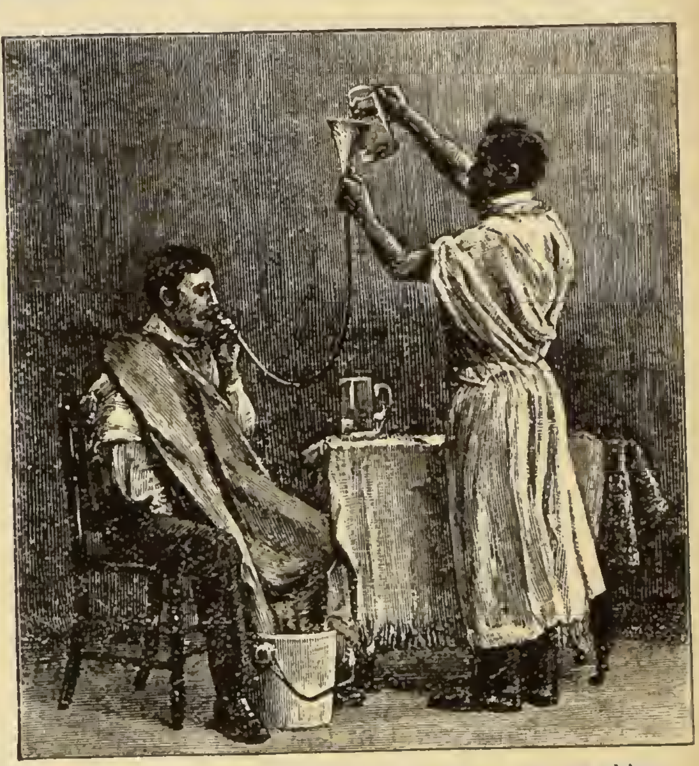


Fig. 111.—A Patient with Stomach-Tube passed for washing out Stomach (Gastric Lavage).

Seat of Swelling.—If the reader will study Plate XII., he will see the position occupied by the stomach in relation to the ribs and front of the body, and if there be any fulness or prominence of the belly accompanying his symptoms of indigestion, he will be able to have some idea whether it is in the neighbourhood of the stomach or not, that is, in the region just below the ribs from the end of the breast-bone down to within 3 finger-breadths or so from the navel and to the left.

The Location of Pain or Tenderness.—The patient, lying on his back with head and shoulders slightly raised and pillow behind knees, should next try to locate exactly the position of pain or tenderness by pressing firmly with his fingers. Fig. 112 shows by dotted circles the chief seats of pain due to stomach disorder, while the seat of pain on pressure in other conditions is indicated by shadings. Appendicitis is frequently ushered in by sickness and vomiting, suggesting stomach disorder, and much precious time is lost thereby. If the pain be near the right groin in the locality indicated in the figure, skilled advice is most urgently required.

The Relation of Pain to Food is very suggestive in stomach disorders. The pain or discomfort is usually distinctly related to the taking of food, beginning soon after a meal, and lasting till the stomach may be supposed to be empty. In ulceration of stomach it usually begins half an hour or so after the meal, and lasts till near the time for the next meal. In some cases the pain is not marked for 1½ hour, and then goes on increasing in intensity till just before the next meal. This suggests ulcer near the pylorus, irritated by the passage of the digested food over it.

If pain, beginning 1½ hour after a meal, is stopped for a time by a fresh supply of food, it suggests obstruction to the outlet at the pylorus, since the propulsive movements of the stomach become active about the time named after a meal, and are allayed for a season by more food. In cancer, the pain may have the characters of that due to ulcer, but frequently it is constant whether food be in the stomach or not.

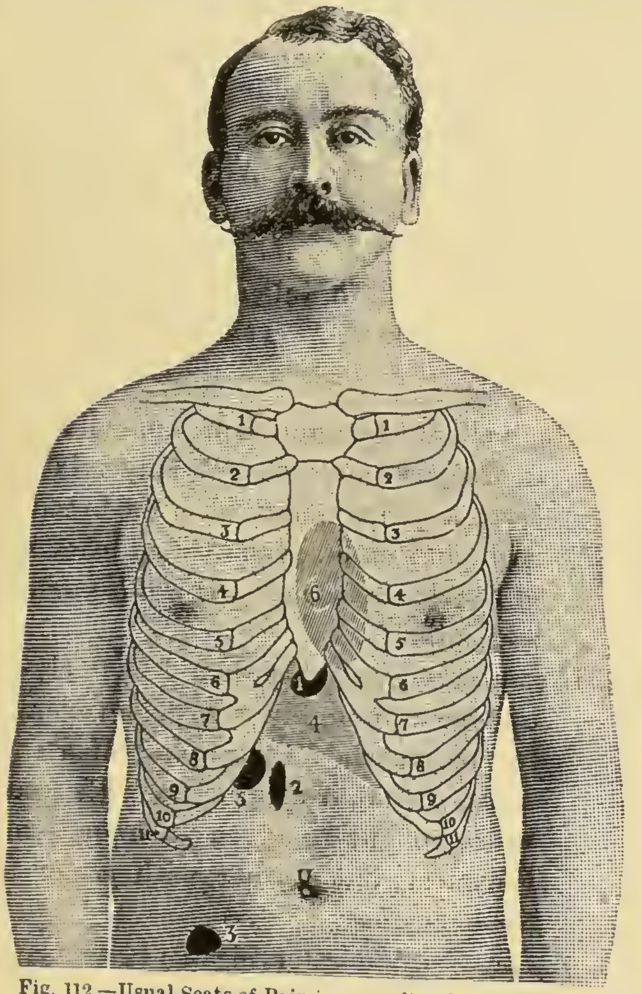


Fig. 112.—Usual Seats of Pain in some disorders of Stomach and Bowel.

1, Ulcer of stomach. 2, Obstructed pylorus. 3, Appendicitis. 4, Chronic catarrh of stomach. 5, Irritation of gall-bladder or gall-stone. 6, Pain due to great distension of stomach by gas, resembling angina (p. 323).

The Character of Pain should help the judgment. In ulcer and irritable conditions of the stomach it is hot and burning, but in the former case it is, as we have seen, usually localized at a small area, while in irritable conditions, as in chronic catarrh, it is diffuse. In obstruction the pain is cramp-like, and is indeed due to cramp-like movements of the stomach wall endeavouring to force the food through the blocked orifice.

Vomiting occurs in diseases that have no relation to the stomach; but when due to stomach disorder any digestive pain or discomfort is usually greatly relieved by the emptying of the stomach. When the stomach is highly irritated, the vomit is very acid, and where there is chronic catarrh the vomit is ropy with mucus. In ulcer the vomit is also highly acid, but it frequently is coffee-coloured from admixture with blood. In dilatation of the stomach the vomiting may occur only once a day, or once in two days, but then a very large quantity is ejected, as if the collection of several meals. If there is bile in the vomit it is a proof that the outlet of the stomach cannot be blocked, since bile should not be able to pass up from the small bowel if it were.

Vomiting also occurs when the stomach is healthy but the bowel is obstructed, and this is certainly the case when the vomit is coloured by and smells of motion.

Eructations of gas point to the stomach as the seat of disorder, and if large and persistent suggest a much distended or dilated stomach, or a very slow digestion.

These are the main facts which would help anyone in arriving at a judgment as to whether the symptoms from which he suffers were due to stomach disease or not.

THE GENERAL TREATMENT OF STOMACH DISORDERS.

If we exclude cancer, and certain cases where the outlet of the stomach has been narrow from birth, one might say that the great majority of stomach disorders are due to errors in diet, and, whatever else may be done, the dietetic errors must be corrected. It will not always follow that the correction of obvious errors is attended by a disappearance of the digestive discomforts. For the stomach is, in many people, a very long-suffering organ, and when at last, by the urgency or persistence of the symptoms, the patient is compelled to pay heed, mere correction of errors is too mild a measure to set back symptoms the final product of the errors of years. When an arm has been strained by excessive work, the pain provoked by movement is the call of the muscle to be let alone to have rest, and when discomfort, sickness, and so on attend the taking of food, these are the call of the stomach for rest. But complete rest can only be given for a short time, for the patient's strength must be maintained.

In acute cases, however, when a few days may be sufficient to get rid of the worst symptoms, if the patient is not emaciated or weak, the reduction of food to the smallest possible amount, of the simplest kind, may be unattended by any risk. But where the patient is already emaciated and weak by prolonged suffering and digestive difficulty, reduction in the food supply may be impossible. In such cases the lightening of the work of the stomach can only be achieved by saving the patient's energy in every way, which means absolute rest in bed. In acute cases this should always be the first step, since when the patient is at complete rest in bed a much-lessened supply of food is called for.

In all cases where symptoms cannot be relieved by correction of obvious errors in diet, it is best to reduce the food to the minimum, or for a day or so even below, and then as improvement takes place gradually to build up a diet.

The minimum may be taken as 3 pints of milk in 24 hours, but it is best to administer it from early in the morning to late at night, but to leave 6 hours or so during the night for complete stomach rest, when nothing is taken unless a little water.

Three pints mean 6 tumblers, or 12 tea-cupfuls, that is a tea-cupful every hour from 8 a.m. to 7 p.m., or, let us say, every hour from 6 a.m. to 12 noon, that is 7 cups, and then every 2 hours up to 10 p.m., that is other 5 cups.

If all discomfort ceases, as it often does, in 24 or 48 hours, then the interval should be lengthened and the amount increased, say 1 tumbler every 2 hours from 7 a.m. to 9 p.m., that is equal to 8 tumblers or 4 pints. If improvement is maintained the interval may be further lengthened and the amount increased, not now by increasing the amount of milk, but by adding something else; thus a tumbler every 3 hours with a rusk, or ¼-slice white bread, stale, broken down in the milk, or a cracker, or plain tea-biscuit. If this is successful, a little milk-pudding may be substituted for the bread, or a portion of an egg which has been dropped into half a pint of hot water and allowed to stay long enough just to set the white. One may substitute for 1 tumbler of milk a breakfast cup of the thin only of chicken or mutton soup, with bread made into a "mush" in it, and the interval lengthened to four hours or varied according to the meal. Later, all symptoms remaining away, small supplies of solids may be introduced in substitution for one of the other meals, say lightly-steamed finely-minced tender beef or chicken or the lean white fish, whiting, haddock, sole, or flounder, with a little stale bread. After such a meal 4½ or 5 hours would be allowed to elapse before a fresh supply of food would be given. Thus gradually a return to fuller and more solid meals would be made. The principles that should guide such meals are these:

1. There should be no mixtures of solids and liquids, except such as easily mix and form a pulpy mass, such as bread or rusk and milk, well-boiled oats and milk, rice and milk, or milk-pudding and milk.
2. If solids are given they should be finely cut up and thoroughly mixed and chewed in the mouth. In the case of a solid meal, liquid, water or a little soda-water, might be given an hour before the meal, but neither with it nor for 3 hours after.
3. A considerable interval should occur between meals, 3 hours elapsing after a meal of bread and milk, or such soft food, before the next, and 4½ or 5 hours after a more solid meal.
4. Spices and condiments should be avoided.

There are, of course, exceptions to these rules, but they must be noted in discussing special diseases.

If the stomach will not bear even a tea-cupful of milk, then a less quantity must be given, but it must be repeated oftener. If even small quantities of ordinary milk cannot be borne, then the milk must be peptonized, or predigested. Directions for this are given on p. 380, Vol. II.

The Bowels must be attended to also, at the very outset. They should be cleared out, to begin with, by means of a full dose of castor-oil, a dessert or table-spoonful. If this does not act soon, an injection should be thrown into the bowel, made of 3 ounces of olive-oil, 1 ounce of glycerine, and 7 or 8 ounces of warm water, sufficiently soapy to make an emulsion with the oil when thoroughly shaken. After the bowels have once been effectually cleared, a good daily motion must be obtained, by administering at the same hour, the last thing at night, as much castor-oil as is necessary. If this is given with perfect regularity, a teaspoonful will probably be found sufficient. If it has not acted by early morning, another teaspoonful should then be given. But all that is wanted is one good movement daily, and if the oil be given absolutely regularly it will probably be found that smaller and smaller doses will suffice. The smallest amount is to be found which will secure the result.

In the event of insuperable objection being persistently maintained to the castor-oil, a teaspoonful of Epsom salts in a tumbler of hot water, on the empty stomach, in the morning, will probably be sufficient, or a wine-glassful of Apenta, Hunyadi Janos, or similar mineral water. But it also must be given with perfect regularity, and only that amount that is found necessary.

Pain in most cases will speedily be relieved if these measures as to diet and clearing the bowel are properly carried out. Once the pain has ceased, its return must be held to indicate an error in the diet, too rapid addition to its amount or variety.

For the first day or so, however, it may be necessary to do something more to relieve the pain. The most useful would be a large warm poultice, or hot fomentation all over the stomach region, repeated as necessary. At the same time the milk may be iced, by putting a piece of ice as large as a hen's egg into the tumbler and pouring over it a cup of milk. Iced milk must, however, be sipped slowly, the cupful taking an hour for its consumption.

Pain still persisting severely, the effect of 5 grains bicarbonate of soda and 5 grains carbonate of bismuth given in water may be tried, repeated every two hours till relief is got. If relief is still delayed, after several doses of the bismuth and soda, 10 drops of the liquor muriate of morphia may be added and repeated for 2 or 3 doses only. The use of morphia, however, is to be withheld as long as possible, and if it must be resorted to, it is to be given up again as soon as relief permits.

Vomiting will, like pain, probably speedily cease, as soon as the reduced milk diet is commenced and the bowels cleared. If it persists, all food, including milk, should be withheld for 6 or 8 hours, chips of ice only being given, or tea-spoonfuls of hot water, the warm poultice or fomentation over the stomach region also being applied. If the relief is not complete in the time mentioned, the same steps may be taken as advised for pain. The dilute hydrocyanic acid is very useful for vomiting, and it may be given in combination with bismuth—3 drops to each dose of 5 grains of bismuth—before morphia is tried.

These are the general lines on which treatment should proceed. What further remedies may be later employed, or what other steps may be necessary, must depend on the particular nature of the stomach disorder, and will be indicated in the short statement that will now be given of a few of the chief diseases of the stomach.

In many cases, a great many cases, indeed, of stomach disease, the steps already detailed will suffice to rid the patient of all discomfort and symptoms. But these will certainly return if careless habits of eating are again followed. The patient should persist in the line of diet and the regulation of the bowels stated above for a long time, many months, to permit of a return of the stomach to a normal tone.

SOME VARIETIES OF STOMACH DISORDER AS INDICATED BY THE NATURE OF THE CHIEF SYMPTOM OF INDIGESTION.

It would be of no value to attempt in a work of this kind to give a technical description or classification of the diseases of the stomach, which chiefly appeal to the sufferer by the type of indigestion they produce. But it may be of some use to take the leading symptom of the indigestion as an indication of the type. The reader must note again that the indigestion is only a symptom, not the disease in itself, that the disease is some change or failure within the stomach, and that the selection of the chief feature of the indigestion as it strikes the sufferer will lead one only a little way.

Slow Digestion is a very common form of indigestion. Its usual symptoms are a sense of weight and fulness after taking food. It is accompanied by costiveness. There are also coated tongue, a bad taste in the mouth, flatulence, and, accompanying occasional discharges of wind from the mouth, there are small quantities of sour material. The failure to digest speedily, and the accompanying constipation, induce a tendency to headache, and a feeling of dulness, mental depression, and disinclination for exertion.

Now very often such a condition of affairs is induced simply by want of proper regulation of times of eating, and of quantity of food, by want of exercise, and so on. In such cases the liver is sluggish. It may be this was the immediate cause of the indigestion, but in any case it tends to maintain and aggravate it. In other cases the indigestion is what is termed **atonic**, that is, due to want of tone. There is lack of energy in the stomach, deficient secretion of gastric juice, or lack of power in the juice to perform its work. This want of tone in the stomach may be simply part of a general condition of body, that general condition, for instance, termed anæmia, in which the sufferer is pale and wants the ruddy look of health.

Its **treatment** proceeds on very simple lines. Let the directions as to diet given on p. 228 be followed. Let regular exercise be taken. If the person is in a position to have horse exercise nothing can be better. For the constipation an excellent remedy is the resin of podophyllin ($\frac{1}{8}$th grain), the extract of nux vomica ($\frac{1}{8}$th grain), and the extract of gentian (1 grain) made into a pill. One such pill should be taken every morning before breakfast. As a rule it produces no discomfort. It gently stimulates the liver and procures an ordinary movement of the bowels sometime during the day. Instead of this a pill containing 5 grains of rhubarb and 1 grain ipecacuanha powder may be used. In either case the pill should be continued for ten days or longer. It cannot, however, be too often repeated that there is no use giving such pills if bad habits of dieting are maintained.

In the atonic form of dyspepsia follow the directions as to diet and bowels given on p. 228. As to special remedies, dilute hydrochloric acid is extremely valuable. It should be given in doses of from 5 to 10 drops in a little water, *always immediately after meals.* In many cases not acid but alkaline treatment is best, but the *alkali must be given before meals.* The best alkaline medicine for the purpose is the bicarbonate of soda, in doses of 8 to 15 grains. Bitter tonics are also prescribed, such as tincture of gentian root, chiretta, &c., which may be given with the soda. (See PRESCRIPTIONS—BITTER TONICS.) In cases of general weakness preparations of iron are used with tonics, for example quinine and iron tonic, &c. (Refer for this also to TONICS.)

Indigestion from Catarrhal Conditions of the Stomach.—This may be put more plainly by saying that the dyspepsia is due to some irritation of the stomach. The irritation may be temporary, in which case the indigestion is likely to be short-lived, and perhaps severe. But if the irritation be chronic the indigestion is of a most intractable sort, indeed, as long-lived as the irritation. The presence of the irritation produces such a condition of the stomach wall as will be noted as occasioning GASTRITIS (see p. 233). In such a case there is loss of appetite, a bitter taste in the mouth, coated tongue, and specially sickness and vomiting, the vomiting, it is to be observed, coming on very soon after a meal. Indeed almost a certain sign of irritability of the stomach is vomiting speedily after food, even when only small quantities have been taken, vomiting not only of food but of a glairy mucus, secreted from the mucous wall of the stomach. If the vomiting be frequent or severe it is likely soon to be tinged with bile, and so people say it is a bilious attack. This is as likely as not a mistake. It is the frequent efforts of vomiting that force up some of the bile out of the small intestine into the stomach, from which it is afterwards expelled. It is the vomiting that causes the bile in the stomach, not the bile that causes the vomiting. Of course the irritation may not be so great as to make the symptoms marked, and they are more or less modified, and accompanied frequently by belching up (**eructation**, as it is called) of badly-smelling gases, when the bowel shares in the irritation. Looseness of the bowels with colicky pain is present. Now an irritable condition of the stomach may be caused by swallowing food hastily, without proper chewing. The remedy is evident, and if it is the want of teeth that caused the food to be swallowed in masses, let false teeth be properly fitted. It may be improper food that has created the disturbance. In this connection it is to be noted that some people are affected by certain quite ordinary foods as if they were irritant poisons. Some people cannot take mutton without sickness and vomiting setting in. Even milk has been known to act similarly. With many people a boiled egg produces nausea, depression, and diarrhœa. A common cold, ending in gastric catarrh (p. 233), will produce this kind of indigestion. But nothing so readily induces the catarrhal condition with its attendant irritability as excess in alcohol.

The **treatment** of this form consists first of all in avoiding all substances that are likely to set up or continue the irritable condition of the digestive organs. All alcoholic liquors and highly-seasoned dishes should be avoided, and the general directions detailed on p. 228 as to diet and bowel regulation followed. Let the tippler not delude himself into the belief that just because of his troublesome stomach he needs an occasional nip to keep him up; and let others take ordinary precautions not to take what manifestly disagrees with them. The powder of ipecacuanha is a favourite remedy for such cases in ½-grain doses. The cases of chronic irritation—chronic catarrhal conditions—are, however, extremely difficult to treat, and a great many remedies have been tried. A valuable remedy is bismuth. Trousseau, the French physician, advises it in large doses along with precipitated chalk, at least 10 grains of each being taken together before each meal. Failing this, acids may be tried—dilute hydrochloric acid taken in 10-drop doses in water at the end of each meal. Effervescing draughts are also useful, and much benefit has often been derived from such an effervescing draught as Eno's Fruit Salt affords, taken early every morning.

Acid Indigestion is marked by an excessive secretion of very acid juice. Severe heartburn is common in this form of the complaint, and every now and again a small quantity of the acid material comes up with eructation, seeming to burn all the way up, till all down the gullet feels raw and fiery, and even the teeth are set on edge. This may go on for hours, and be accompanied by a sense of fulness as if the food were unable to escape from the stomach. The acidity is often accompanied by flatulence.

Treatment.—Again it must be insisted on that the person regulates his food with care. The directions on p. 228 as to diet and bowels are particularly suitable to such cases. Now it is certain that often nothing relieves this condition like an antacid (a substance opposed to an acid) such as soda or magnesia, of which half a tea-spoonful may be taken in water. A tea-spoonful of seidlitz salt dissolved alone in water is useful, and helps also to relieve the bowels. The subnitrate of bismuth, 10 to 15 grains, a quantity that can easily be picked up on a sixpence, is also advised. It is, however, frequently the case that acidity is best treated by other than alkaline remedies, apparently because medicines like soda, &c., stimulate, by their opposition, an increased secretion of acid. Thus acid indigestion yields most readily in many cases to acid treatment, but the acid (10 drops of dilute hydrochloric acid in water) must be given *a short time before each meal.* When given at this time it checks the excessive secretion of acid and prevents the development of acid by fermentive changes in the stomach.

Flatulent Indigestion is characterized by the formation of gases in great quantity in the stomach and bowels. The gas is supposed to be produced by decomposition of the food. The gases may have a very bad odour. Their presence is indicated by fulness, distension, and pain, and their movements through the bowels are attended by gurgling noises. Flatulence is often accompanied by acidity.

Treatment.—In very many cases confirmed flatulent indigestion is due to nothing else than bad regulation of diet, to too long intervals between meals, and to the too frequent use of tea. Let these errors be first of all corrected.

It is in cases of indigestion in which belching up of quantities of gas is a prominent symptom that milk may prove to be an unsuitable food. Small solid meals at intervals of not less than 4 hours may prove more suitable. But solids which readily ferment must be avoided, such as potatoes, starchy foods like rice, tapioca, &c., and pastries and sweets. Tea should be much restricted in amount, and freshly prepared and weak, with cream, but very little sugar.

Liquids should be taken apart from meals, preferably an hour before a meal, and gaseous waters should be avoided. Fat and all greasy dishes are objectionable, fresh butter, however, being allowed.

Such a diet would consist of—

BREAKFAST (SAY 8.30 A.M.): A single cup of tea, with cream and little or no sugar; white fish, boiled or grilled; stale or thoroughly toasted bread, with butter put on when the toast is cold.

MID-DAY MEAL (SAY 1 P.M.): The thin only of any soup which may have been cooked with vegetable, but none of the vegetables are eaten, and no thickening is added (clear soup), with half-slice thin, crisp toast.

5 P.M.: One small cup of perfectly fresh tea, with a couple of small crisp biscuits or toast biscuits.

7 P.M.: A small dinner of a little white fish, a cutlet, small chop, or small cut of lean beef or mutton, or piece of chicken; with soft mashed turnip, or well-cooked cauli-

flower, sprouts, French beans, or green peas, and half-slice crisp toast.

BED-TIME: A tumbler of hot water with quarter tea-spoonful bicarbonate of soda and a pinch of salt.

If dinner is taken about 1 p.m. the meal suggested for 7 p.m. should be taken, and nothing after that till 6.30 or 7, when a meal similar to breakfast may be taken, or a tumbler of hot milk with stale bread and butter may be tried for a change.

It should be noted regarding green vegetables that, though they are commonly avoided for flatulency, it is, in the author's opinion, because of their usual mixture with potato or milk-pudding in a much-mixed meal. They will be found, usually, to suit quite well with lean meat of any kind if these mixtures are avoided.

Where the flatulence is the main symptom, and the gases appear to be developed by fermentation, charcoal is the best remedy. It should be taken either soon before or immediately after food, according as the wind is developed immediately on eating or some time after. The dose is 5 to 10 grains of wood charcoal. In other cases, where flatulance is only one of other general dyspeptic symptoms, an acid with some vegetable tonic is valuable. (See PRESCRIPTIONS—ACID TONICS.) In women flatulent dyspepsia is often accompanied by palpitations, headaches, attacks of giddiness and faintness, &c. In such conditions the aromatic spirit of ammonia with spirit of chloroform is very beneficial. (See PRESCRIPTIONS—AMMONIA MIXTURES.) The popular remedy, peppermint water (2 table-spoonfuls) or 2 drops of oil of peppermint, gives temporary relief. So also does ginger, 5 to 20 grains in warm water, or tincture of cardamoms, a tea-spoonful in water.

Indigestion with Excessive Appetite.—There is a persistent feeling of emptiness in the stomach, uneasiness, and craving for food even a short time after food has been taken. These sensations are accompanied by a feeling of weakness, of "goneness" as many express it. This craving for food is termed **bulimia**, and is common in women. The condition seems often due to the food being too rapidly passed on from the stomach into the bowels, so that digestion is not properly accomplished. Looseness of bowels usually is present.

The **treatment** for this kind of indigestion is opium in some form or another, and in very small doses. Let the person begin with a drop of laudanum *before meals*, and if this quantity is not sufficient let the number of drops be slowly increased till the proper dose is found. In no case, however, should the dose exceed 10 drops or thereby, and *as soon as the symptoms have disappeared its use should be given up*, only to be resorted to again if the symptoms return.

Painful Digestion.—Pain is an accompaniment of various kinds of indigestion. Heartburn is one kind of pain, and flatulence usually causes pain also. In these cases treatment for the acidity causing the heartburn, or for the flatulence, ought to remove the pain. Again, a sense of uneasiness may grow to actual pain in slow and weak digestion, for which the remedies mentioned under SLOW DIGESTION ought to be used. The pain may take a spasmodic character, and may extend to the back between the shoulders—the kind of pain popularly called "**cramp in the stomach**", and more learnedly **gastrodynia** (*gaster*, the stomach, and *odune*, pain or anguish). The nitrate of bismuth in 10-grain doses is very useful for this, and if this fails 3 grains of the compound ipecacuanha powder should be added to it. Sometimes the hydrochloric-acid treatment (4 to 8 drops *immediately after a meal*) is efficacious for this affection also. The **water-brash (pyrosis)** is another form of painful digestion. Pain at the pit of the stomach is followed by the putting up of mouthfuls of a watery and sour, or sometimes insipid, fluid. The pain is often severe, and the quantity of fluid considerable. Bismuth should be used as prescribed for cramp in the stomach. If necessary, acids may be tried before food if the fluid put up be sour, after food if it taste insipid.

In some cases pain is experienced when the stomach is empty, and is relieved by food. Eating a small biscuit often puts away the pain at once. A little magnesia or a tea-spoonful of aromatic spirit of ammonia may be employed if needful.

Such, then, are the main types of indigestion. Again, however, it must be noted that the distinctions drawn are merely those of convenience, and that no real distinctions can with certainty be made. Even after proceeding in the most careful and rational manner, treatment of dyspepsia may fail till several remedies have been tried.

One or two additional remarks of a general character may be made.

It will perhaps be noticed that alcohol is nowhere advised in these paragraphs. This is not because it is valueless, but because of the risks involved in recommending it. Many people need only the hint that whisky or brandy would be useful, to seize upon it, and make it an excuse for tippling. Indeed one may say that the cases are so few where some substitute for alcohol cannot be found, that it is safer to leave its prescribing to the hands of a medical man who has immediate knowledge of the individual case.

While a certain amount of water is necessary for the digestion of food, dyspeptic symptoms are frequently due to the immoderate use of water during meals. When it is desired at a meal it should be taken chiefly at the end, and in small quantity. Iced drinks during meals frequently hinder digestion. (Details as to drinks are to be found in the section on HYGIENE—FOOD.)

Dyspepsia may be due to no derangement of the digestive process, properly speaking, but to confirmed costiveness. The remedy in such a case is to correct the sluggish bowels—it is frequently the large bowel that is at fault. A drug highly recommended for this is belladonna, the method of using which is stated in the paragraphs on costiveness (p. 245).

In women various forms of indigestion are frequently connected with affections of the womb and derangements of its functions. Often as soon as these are rectified the dyspeptic symptoms disappear.

Hiccough or Hiccup is a symptom of stomach derangement which has not been mentioned in preceding paragraphs. It consists of sudden, short, convulsive inspirations accompanied by a pecular sound, and followed by an expiration. It is due to convulsive movements of the diaphragm (p. 345), and is excited by irritations of the stomach due to errors in diet, &c. If it continue for any time it becomes extremely painful. It becomes very exhausting in cases where it is removed with difficulty. Drinking, it is well known, occasions it, and sometimes it persists for days, to the extreme distress and anxiety of the patient. It is also an occurrence in hysteria, and may attend serious diseases of lungs or liver, fevers, &c. Whenever there are any severe or long-continued stomach or bowel symptoms, persistent hiccough is a very serious symptom.

Treatment.—Simple cases are sometimes met by taking a few deep inspirations and then holding the breath as long as possible. A sudden slap on the back or a sudden start often drives it off. A drink of cold water may arrest it. These measures failing, various remedies may be used—a tea-spoonful of aromatic spirit of ammonia in water, a few drops of spirit of camphor in water, or 10 grains of bismuth in water. Obstinate cases have been immediately cured by the drinking of an infusion made with a tea-spoonful of mustard steeped in 4 ounces of boiling water for twenty minutes and then strained.

We must now consider some of the chief stomach diseases attended by marked structural changes in the stomach.

SPECIAL AFFECTIONS OF THE STOMACH.

Inflammation of the Stomach (*Gastritis*) is in its acute form a very rare disease, unless when produced by the action of corrosive substances, such as vitriol, carbolic acid, &c., that have been swallowed.

Its **symptoms** are chiefly very severe pain over the region of the stomach and lower part of the chest, pain which is burning, and is increased by pressure over the part. Even the pressure produced by ordinary breathing greatly aggravates the pain, so that the person takes short, shallow, quick breaths. There are retching, hiccup, and vomiting, and loss of appetite. Nothing can be retained in the stomach. The pulse is quick and small, there is fever, and the person becomes rapidly weak and exhausted. Death may occur very rapidly.

The **treatment** is largely determined by the cause. If an irritant poison, such as one of the mineral acids, has been taken, substances like chalk and water, magnesia, &c., should be given to destroy the burning tendency of the substance. The proper treatment for each case is considered in the chapter on POISONS. The general treatment consists in placing hot applications over the region of the stomach, in giving the person ice to suck, and in the use of opium, 1 grain every three or four hours. The opium, however, may not be retained in the stomach, so it may be given in injection (see INJECTIONS) or as a suppository (see SUPPOSITORIES). A medical man would likely administer it by injecting it under the skin.

Acute Gastric Catarrh (*Cold-in-the-Stomach*).—This is an inflammatory condition of the mucous lining of the stomach (see p. 198), akin to the catarrhal condition of nose and throat that has been described. It is frequently due to cold.

Symptoms.—The person is very sick, and has severe headache. There are pain over the stomach and a feeling of soreness in the back and limbs. The vomit is of mucus, and is coloured with bile, which causes the disorder to be called a "bilious attack." The tongue is very much coated with a white fur. The pulse is quick and full, and the skin hot. Often the temperature will rise to 103°. The urine is dark, and a brick-dust deposit falls when it cools. Severe cases are called attacks of "gastric fever," though this is a term discarded by modern physicians.

The **treatment** consists in keeping the patient quiet in bed. Let food be in accordance with the directions on p. 228. The sucking of ice will greatly check the sickness and vomiting. The most valuable medicine is a powder composed of 5 grains of Dover's powder and 8 grains of bismuth. The dose may be repeated every four hours for three or four powders. (*It is only for an adult.*) Thirst may be relieved by soda-water, or sips of iced water or iced milk. As soon as the acuteness of the attack has passed, the bowels (which the powders tend to constipate) should be freely opened by a dose of saline medicine, Eno's fruit-salt, seidlitz, or effervescing citrated magnesia, &c.

Chronic Inflammation of the Stomach (*Chronic Gastritis—Chronic Gastric Catarrh*) is a common disorder, and may be produced by a great variety of causes. Cold, the swallowing of irritating substances, irregularity in taking food, bad food, or food that is ill cooked and so not easily digestible, too much food, badly-chewed food, and very particularly frequent use of stimulants, all these may occasion it. In addition, chronic inflammation may be the result of some other disease, such as a disease of lungs or heart, preventing a proper circulation of the blood, and so leading to constant over-fulness of the blood-vessels of the stomach and other parts of the alimentary canal.

The chief **symptoms** are loss of appetite and indigestion. There may be tenderness over the stomach. Vomiting of a large quantity of glairy mucus is common. Sometimes, instead of loss of appetite, there is craving for food, but, even though craving it, the person has taken only a small amount when sickness and a sense of overloading arise that make him desist. The bowels are usually confined; the breath is foul, and there is a bad taste in the mouth. Naturally the person suffers in general health, is low-spirited and irritable.

The **treatment** of such cases is sometimes very difficult. Much may be done without medicine by methods of feeding. If vomiting after food is a frequent occurrence, then very small quantities of food, chiefly milk, should be given often. Begin with a spoonful, and let it be repeated at intervals, and slowly increased as the stomach tolerates it. The stomach may be coaxed in this way to digest food which it would immediately reject if it were given in any quantity. If the bowels be constipated some medicine is necessary. In such cases nothing suits better than a saline medicine taken in early morning before breakfast. The Carlsbad salts obtained in crystals and dissolved in water (one or two tea-spoonfuls in a tumbler of water) are specially valuable. Failing Carlsbad, Hunyadi Janos mineral water (a claret-glassful) may be used, or some effervescing saline medicine. Stimulants should not, as a rule, be employed. Some tonic medicine should also be used if the stomach will tolerate it—iron, quinine, and strychnine, or an acid tonic (see PRESCRIPTIONS—TONICS). The person troubled with such an affection should also take mild regular exercise, should avoid salted and highly-spiced meats, and should avoid damp and wet.

Ulceration of the Stomach.—"An ulcer of the stomach" is, in the eyes of most people, one of the most hopeless of troubles. Yet it is probable that a very large number of persons suffer from it, the symptoms being chiefly those of dyspepsia, and recover from it, and have no suspicion as to the true cause of their indigestion. Undoubtedly ulcers may end in death after long and painful suffering, but, as undoubtedly, they very often end in recovery.

Women seem more liable to the disease than men, and it is commonly associated in women with derangement of the monthly periods and bloodlessness. It may also be the results of dissipated habits and of syphilis. It is a disease of middle life, and the liability to it increases as life advances.

The history of an ulcer of the stomach may vary. It is first limited to the inner coat—the mucous membrane—and may be of such a nature as if a piece of the membrane had been punched out. The tissue surrounding it is increased in amount, through an effort of nature to repair the breach. This effort may be successful, and the rampart of thickened tissue, thrown up, as it were, round the ulcer, may gradually encroach on it, the ulcerated surface narrows more and more till it is obliterated, and nothing may remain but a depressed puckered scar. Why this does not speedily take place is doubtless due to the constant worrying to which a healing ulcer is subjected in the stomach by the movements of the stomach walls, by the passage of food of all kinds over it every now and again, and by the irritation of the gastric juice, poured out whenever food is admitted into the stomach. The stomach ulcer wants that first requisite for speedy recovery—rest. Doubtless very often the ulcer does not heal because of the general condition of the person's health or the special condition of the blood, a person with bloodlessness (anæmia) or syphilis, for example. If the ulcer does not heal it may spread, extending itself gradually over wider portions of the mucous membrane, and growing more deeply into the stomach walls, the patient, all the time, becoming more and more exhausted, and finally dying of exhaustion. In the course of eating its way through the walls of the stomach, the ulcer may open into a blood-vessel and cause serious bleeding, ending in death either by sudden and great loss of blood, or by exhaustion produced by several attacks of bleeding. The ulcer may eat its way entirely through the walls of the stomach, producing perforation, so that the contents of the stomach escape through the opening into the cavity of the belly and there set up inflammation (peritonitis), which speedily kills. Instead of making an opening into this cavity, the ulcer may be in such a position that it opens into the large bowel behind, or at the surface of the pancreas, or other part to which the stomach may have become adherent by the inflammatory process which the progress of the ulcer has set up. In a case where the stomach is adherent at the seat of ulcer to some other organ, actual perforation may be prevented by the adhesions, and peritonitis not arise. In the event of the stomach being adherent to the large bowel behind, the ulcer might eat its way through the adherent walls of both organs, and thus a communication exist between stomach and large bowel. Food might thus pass directly from the stomach into the large bowel, and nourishment be thus seriously interfered with. Similarly, fæces might pass from the large bowel into the stomach, and be vomited by the person.

The **symptoms** of ulceration of the stomach are chiefly pain, vomiting, especially vomiting of blood, and general dyspeptic symptoms. Indeed, at first, the symptoms are chiefly those of dyspepsia, such as have already been described (p. 227), bad appetite and bad digestion, fulness after food, flatulence and uneasiness after food. When the symptoms have grown worse, so that pain is actually developed, it may be felt over the stomach or at the back on a level with the beginning of the lumbar vertebræ, or between the shoulders. The pain is increased on pressing over the stomach. It is aggravated after food, reaching its greatest intensity about two hours after food. It may be caused by the entrance of food into the stomach, and may arise immediately or a few minutes after the food has been taken, and is of a burning character. It lasts till the food may be supposed to have passed on to the small bowel, or till vomiting has occurred, emptying the stomach and so producing relief. Vomiting may become so frequent as to occur some time after every meal, and is a serious element in the disease, since the nourishment of the patient is thereby gravely affected.

Vomiting of blood (*hæmatemesis*) is an occurrence of ulceration owing to some blood-vessel being opened into. A large and sudden loss of blood may in this way occur, tending to cause the speedy death of the person by collapse, or frequent bleedings may take place, which very quickly reduce the patient's strength. The ordinary vomit consists of the food partly digested and of mucus; but, if mixed with blood not in sufficient quantity to be recognized as such, there is the appearance of "coffee grounds," due to the blood being altered by the action of the gastric juice.

If the ulcer open into the cavity of the belly it will be known by sudden severe pain, great prostration and anxiety, and the speedy occurrence of inflammation of the whole cavity of the belly, the symptoms of which are described under the heading PERITONITIS (p. 265), which speedily ends in death. This termination of the disease may be provoked by a large meal, or by some exertion which exerts pressure on the wall of the stomach, and so bursts through its weakened portion.

Treatment of ulceration of the stomach demands the care and skill of a physician. Of course the recognition of the disorder equally requires a well-trained physician. The symptoms that have been mentioned will enable anyone to recognize a serious condition requiring careful attention. But for the treatment it is not enough even to be sure of the fact that an ulcer of the stomach exists. For the treatment of this disease, as of almost all others, requires the consideration of many other circumstances. It is often a difficult question even for a skilled physician to give an opinion as to the presence or absence of ulcer; but even though he is convinced of the existence of ulceration, the question of treatment may be one of difficulty. Therefore, if this condition is even suspected, medical aid should at once be sought. The principles that have been already laid down in detail on p. 227 apply very fully to the treatment of gastric ulcer. The food is probably best given tepid, and never hot or cold, to avoid stimulating the stomach. This diet may be reinforced by nourishing injections. (See list of nourishing injections, Vol. II., pp. 15 and 406, and for use of injection apparatus refer to APPLIANCES FOR THE SICK-ROOM, p. 20, Vol. II.) In some cases the use of raw pounded beef, given also in small quantities, has proved useful.

The methods of relieving pain and vomiting are stated on p. 229.

If bleeding occurs, no food is to be given for one or two days, nourishment to be maintained by injections, ice to be sucked, and doses of 10 grains of gallic acid, or 15 drops tincture of steel, to be given every six hours, to cause contraction of the bleeding vessels, the person being all the time kept perfectly quiet.

Perforation of the wall of the stomach, occurring as the result of ulceration, is known by sudden severe pain, followed by collapse or great prostration. The pain rapidly spreads over the whole belly, owing to the occurrence of inflammation of the lining membrane of the cavity—the peritoneum (see p. 265). Death may occur a few hours after the perforation, unless the nature of the occurrence is immediately recognized, and an operation undertaken. An operation in such circumstances is attended by great risk, but in the hands of a skilful operator is very often attended by recovery.

Operation is often quite properly undertaken, in prolonged cases of gastric ulceration, as a means of cure, when no such urgency exists as when perforation has occurred. It is often, indeed, necessary when an ulcer, by its contraction or by the formation of adhesions, has narrowed the stomach outlet, and is causing dilatation, and stagnation and retention of food. The common operation in such a case is that of gastro-enterostomy, by means of which a new opening is made between the stomach and bowel, permitting the food to pass into the bowel without passing over the ulcerated surface, which thus gets the opportunity of healing. It is one of the most useful of the modern operations in gastric surgery in suitable cases.

Cancer of the Stomach is not an uncommon disease, though it seldom occurs before the age of forty. It may exist in any of its various forms. (See p. 556.) Life is seldom prolonged beyond two years after its commencement.

Its **symptoms** are not always marked, and may be those of dyspepsia such as might arise from chronic catarrh. Many cases are recorded of death from cancer, in which there were no symptoms which could have led anyone to suspect the true nature of the disease. In most cases it is, therefore, a question of great difficulty for even a skilful physician to decide whether a person is affected with cancer of the stomach or not. Apart, consequently, from such skilled opinion, no one ought to conclude that he or she is affected with this disease, since very simple affections of the stomach may produce similar, and even more severe symptoms. It would be well if this warning were laid to heart. Many people are so constituted that to tell them they are affected with cancer is to issue their death-warrant. It produces such an effect upon them as to lead to their death even suppose they have no cancer, but, perhaps, merely some chronic catarrh.

The parts of the stomach most commonly affected in cancer are, firstly, the neighbourhood of the junction between the stomach and the small intestine (the pylorus); and, secondly, the junction between stomach and gullet. The thickening, which is a common result of the disease, is apt to narrow the opening, so that the passage from stomach to intestine is contracted in the one case and that from gullet to stomach in the other. In the former case the food, which has been digested in the stomach, finds its onward passage obstructed. It is thus retained in the stomach and vomited after a longer or shorter interval, probably an hour or two after being swallowed. The vomit will consist of the partially-digested food, mixed with secretion from the stomach. If the cancer has undergone ulceration and sloughing, the vomit will contain very offensive matter discharged from it.

From the ulcerated surface also there is likely to be oozing of blood, which will have the "coffee-ground" appearance, because of the action on the blood of the contents of the stomach.

Sometimes obstruction at the pylorus leads to accumulation of food in the stomach for a considerable time. This leads to dilatation of the organ. The accumulated food is at length vomited, and so an enormous quantity may be vomited at one time. (See Dilatation of the Stomach, p. 238.)

If the obstruction is at the gullet opening, then food which is swallowed will pass down a considerable way, and then, not able to get into the stomach, will be immediately returned.

Besides such symptoms there will be loss of appetite, pain, and vomiting, which is likely to occur even though no such cause as that of obstruction to the onward passage of the food be present.

No treatment for the cure of the disease is known. The treatment, consequently, is merely palliative—employed, that is, for the relief of pain and such symptoms. Proper nourishment must be given in a form that is easily digestible—milk, if it is well borne, beef-tea, fish, eggs, &c., given in small quantities often, to overcome irritability. Sooner or later, in most cases, opium is resorted to to relieve pain. The longer this can be delayed the better, since the use of opium grows upon patients. A dose sufficient to induce sleep at first soon becomes too little, and increasingly larger and larger doses require to be administered. Not more than ½ grain of opium should be given to begin with.

Whenever cancer of the stomach has reached the stage when it produces obstruction of the outlet and retention of the food, milk usually ceases to be a suitable diet, and beef extracts and jellies, and small solid meals of scraped fish or meats with crisp thin toast often suit better.

If the true nature of the affection is determined early (see p. 223 for information as to methods of determining), and the patient is fit to bear it, an operation may be of immense value by forming a new outlet to the stomach.

Bleeding from the Stomach (*Hæmatemesis*).—Blood may escape from the vessels into the cavity of the stomach in many kinds of disease. In cases of ulceration, either simple or due to cancer, the quantity may be very large. Simple congestion, due to disease in the walls of the stomach itself, or because of obstruction to the passage of the blood by disease of the liver, for example, or disease of the heart, may also occasion it. Hæmorrhage from the stomach also occurs in scurvy and a disease called purpura, to which refer. It must also be noticed that a considerable number of cases have been known of women who had no regular monthly discharges from the womb, but had monthly discharges of blood from the stomach or lungs. Cases also have occurred where suppression of the monthly flow was followed by discharges of blood from the stomach. If it escape in any quantity it is likely to be vomited, and to be easily recognized. The coffee-ground appearance of the vomit due to altered blood has been referred to under Ulceration and Cancer of the Stomach. Blood may escape into the stomach, and, not being vomited, will pass on into the bowels, to appear in the stools. It does not then appear in its usual colour, because of the action of the various intestinal juices on it, but makes the fæces black and tarlike. Of course if the presence of blood be evident in the fæces there is nothing to show whether it has come all the way from the stomach or from the intestines only.

Symptoms.—If a large quantity of blood escape suddenly into the stomach there may be faintness, pallor, insensibility. Sometimes the sudden loss of large quantities of blood produces convulsions because of the want of blood in the brain. Immediately, or within a short period, vomiting of the blood will occur and reveal the cause of the faintness. Vomiting of blood is to be distinguished from spitting up of blood from the lungs. The former occurs after some feeling of sickness; the latter is not vomited but coughed up, after some tickling in the throat. Blood from the lungs is usually bright and mixed with air, that from the stomach is usually dark.

It should be noted that blood that is vomited does not necessarily proceed from the walls of the stomach. It may have proceeded from the back of the nasal passages or throat, and may have been swallowed unconsciously, to be afterwards vomited. In all cases, therefore, the back of the throat should be examined. Sometimes a streak of blood will be seen passing down from the position of the opening of the nasal cavity behind, indicating the source of the blood.

Treatment should never be adopted without proper medical advice. The reason of this is readily understood. Suppose the bleeding to be due to opening of some blood-vessel by ulceration, what are called *styptic* remedies are employed, remedies like gallic or tannic acid and tincture of steel, which act by contracting the bleeding vessels. But suppose the bleeding to be due to escape of blood from gorged blood-vessels, whose congestion is due to the liver, plainly styptic remedies are useless, and a successful plan of treatment must remedy the liver defect and so relieve the too full vessels. Again, should the bleeding be an effort of nature to get rid of a discharge by this channel, when the ordinary channel of the monthly flow is denied to it, it is clear that, besides giving medicines like tincture of steel, or ordering the sucking of ice, to arrest the discharge from the stomach, efforts must be made to restore the usual and regular discharge. It is necessary to repeat, therefore, that if rational treatment is to be adopted qualified advice should be sought, so that not merely the escape of blood, but the cause of that, should be taken into due consideration. However, it is well to know, in case of some delay in getting advice, and where copious discharge of blood exists, that the person should be kept quiet and at rest in the horizontal position, that ice should be given to suck, and no warm food or drink permitted, and that doses of tincture of steel (15 drops) or gallic acid (5 grains) should be given to contract the vessels.

Dilatation of the Stomach has been commented on in the preceding paragraphs on cancer. Mechanical obstruction to the passage of food from the stomach to the small intestines, such as a tumour can produce, will readily cause dilatation or expansion. Dilatation may exist without any such obstruction. It may be the result of habitual overfeeding, or habitual swallowing of badly-chewed food, or the habitual use of indigestible kinds of food, or any other cause which gradually deprives the muscular wall of the stomach of its tone, so that its walls yield and fail to contract upon their contents.

The **symptoms** are fulness in the region of the stomach, flatulence, heartburn, uneasiness, and vomiting. The quantity vomited is often very large, several meals being sometimes retained and then rejected together. Owing also to the want of regular complete emptying of the stomach, fermentive changes are set up in the stomach, and as a result the vomit may have a sweetish taste.

The fermentation in such cases is frequently set up by the presence in the stomach of the *yeast fungus*, or of another active agent in fermentation called *sarcinæ*. They are detected by means of the microscope.

Treatment of such cases requires patience and adaptation to the particular instance. Thus a case of dilatation pure and simple would obviously be much more easily treated than one due to obstruction. In any case small quantities of light easily-digested food should be given at a time. Liquid foods are not, as a rule, so well borne as small solid meals in a very fine state of division, given at intervals of not less than four hours. The regular daily use of the stomach-tube, nightly or in the morning, to empty and wash out the stomach, effectually relieves the symptoms as a rule. Electrical treatment, for the restoration of muscular tone, and tonics like strychnine are the main agents in treatment.

In some cases of simple uncomplicated dilatation remarkable results have been obtained by administering, early every morning before breakfast, four tea-spoonfuls of the Carlsbad Spreudel-saltz dissolved in a pint of water, the whole pint to be taken at once. [The salts are obtained in bottles from chemists, but they are rather expensive.]

Where sarcinæ are suspected to be the cause of fermentive changes in the food in the stomach, 20 to 60 grain doses of the hyposulphite of soda should be given.

If the case is one of obstruction, there are several operations, one, already named, gastro-enterostomy, by which a new outlet is provided, and another, pyloroplasty, by which the narrowed pyloric outlet is widened.

Obstruction at the Outlet of the Stomach (*Pyloric Stenosis*) may exist from birth (see Diseases of Children), or may be a consequence of ulceration or a new growth. It leads to dilatation. Its remedy is operation.

DISEASES OF THE BOWELS.

INTESTINAL INDIGESTION.

Disturbances of digestion may exist in prolonged and serious forms when there is no disorder of the stomach, due to mischief of some kind or other in the small or large bowel or other abdominal organs. This is easily understood when one recalls the important part of digestion carried on in the small bowel in particular, by the chemical action of digestive juices secreted by the glands in the bowel wall, and poured into the bowel from the liver and sweet-bread, all of which facts have been carefully stated in the preceding section.

The integrity of the digestive process in the bowel is dependent upon a much larger number of circumstances than that of stomach digestion, and the possibilities of disturbance correspondingly increased. For, in the case of the stomach, if the entrance to it and exit from it are unimpeded, if the tone of its muscular wall is unimpaired, and if the juice produced within its own glands is sufficiently active, all the conditions exist for healthy stomach digestion. But in the case of the bowel, intestinal digestion depends not only on the integrity of the bowel itself but also upon the harmonious cooperation of other organs outside of it, notably the liver and sweet-bread. As regards the bowel itself, we have seen that it is of considerable length, about 26 feet, including the large bowel. In a great part of this length the tube is comparatively narrow, and at the place where it enters the large bowel, the ileo-cæcal valve (p. 199), the width is greatly reduced. Any growth or thickening at any part of the wall along its whole length might easily gravely constrict its fairway, while the pressure upon the wall by any inflammatory mass or new growth outside of it might easily block it completely. Then the tube of the small bowel is coiled irregularly within the centre of the abdominal cavity, the smooth external surface of the intestine permitting the coils to glide easily upon one another. But any inflammatory mischief within the cavity interferes with the smoothness of this surface and readily causes one coil to adhere to another, limiting its freedom of movement. Inflammation may in this way not only glue together, so to speak, a mass of coils which ought to be able to roll and glide over one another, but this gluing process might bind down a coil in an inconvenient position, producing sharp bends or "kinks" on the tube, which would seriously hinder the passage of the food-stuffs along the canal of the tube.

But we have seen that the contents of the intestine are propelled along the tube by a wave-like movement (peristaltic movement) that passes along the intestinal wall in a spiral manner. As this wave slowly passes along, it constricts the tube at the part over which it is passing, and anything within this part of the tube, at the time the peristaltic wave is passing over it, is squeezed on, so to speak, into the next part of the canal. So the contents are gradually propelled from one end to the other.

Any inflammatory adhesions between separate coils of the bowel, or between coils of the bowel and other structures outside of them, would upset the progress and hinder the effect of this peristaltic wave movement.

But the bowel being loosely coiled in the centre of the abdominal cavity, and attached to the back wall of the cavity by a delicate membrane, the mesentery, it is always possible for a coil or a mass of coils, by an exaggeration of the normal peristaltic movement, to roll right round on itself and thus cause a complete twist in the tube. Such an occurrence is called **volvulus.**

Again, the mucous or inner lining membrane of the intestinal tube is subject to catarrhal affections, just as the mucous lining of the nose or throat or stomach is. Such catarrhal swelling alters the proper secretion of the tubular glands, embedded in the mucous lining, either diminishing it seriously or increasing it and altering its character, just as the ordinary healthy secretion of the nose is affected by a cold, being in one variety diminished and so causing excessive irritability and dryness of the nostrils, and in another variety being excessive, watery, and mucous. Thus, speaking broadly, digestion within the bowel may be disturbed either by (1) some irregularity of the secretion from the wall of the bowel itself, or (2) by some interference with the freedom of the bowel in the movement of its wall.

Thus there is a class of disorders of the bowel which spring from some alteration in its secretion, and a class of disorders which spring from some change in its mobility. But as we have said, it is not a single juice, produced within the wall of the bowel itself, that carries on the digestion in the bowel; on the contrary, digestion within the canal of the bowel is much more dependent upon juices imported from organs outside of it, and so the chances of disorder are greatly multiplied. Thus any one of the numerous diseases of the liver may manifest itself by a disturbance of intestinal digestion, provided it affects the amount and quality of the bile delivered to the bowel, and so also may any one of the at present ill-defined affections of the pancreas do the same by affecting the amount and character of the pancreatic juice.

It has also been pointed out that the veins which carry off the blood which has circulated through the stomach, bowel, spleen, and pancreas unite to form one large vein, the portal vein (p. 200), which passes to the liver. Any obstruction to the flow of the portal blood through the liver would lead to engorgement, or congestion of all the veins of the organs named, which would be a very serious result.

Of indigestion arising in the bowel, therefore, may one say most emphatically what has been said of indigestion arising within the stomach, that it is no mean task to unravel its mazes and to arrive at a correct judgment of its true character and cause. One may, therefore, ask the same question regarding the bowel we have already tried to answer regarding the stomach, how does one arrive at a decision regarding the nature and cause of its disturbance?

THE CONVICTION OF THE BOWEL AS THE SEAT OF INDIGESTION.

A similar routine may be followed as has been described in the case of the stomach. The patient lies on his back, with knees supported by a pillow, head and shoulders being slightly raised, and is asked to relax as far as possible his belly walls. The appearance of the abdomen is then observed. If there is any undue prominence or retraction its locality is noted, specially with regard to the organs which lie within the cavity in that situation. Reference to Plates XII. and XIV. will assist anyone to decide what organs lie under that part of the belly wall.

In some cases of bowel disease, specially when a coil of bowel is narrowed or bound down in the way described, or blocked in any way, the ordinary gentle spiral movement (peristaltic) is exaggerated, in the endeavour, so to speak, of the bowel to liberate itself or to force its contents onwards, and this exaggerated movement may be visible on the belly wall over a limited area. Specially is this likely to be so in the case of obstruction which has existed for some time, since, if one part of the tube is narrowed, the part immediately above the block is likely to bulge unduly from a collection of retained material. Reference to Plate XII. and its description will assist one in deciding what part of the bowel it is that is involved in this unusual movement.

The hand of the observer is then laid on the abdomen to determine whether the whole of the belly wall is equally soft and yielding, or whether it is soft and yielding in one place and held rigid at another. By the movement and pressure of the hand and fingers the presence of swelling, increased resistance, pain or tenderness, may be settled, and the Plates noted will aid in suggesting what organs are in the neighbourhood of the swollen or painful or tender part.

In the case of the bowel one cannot obtain, in the same way as one can in the case of the stomach, a sample of the contents for chemical analysis. It is clear, however, that evidence of a kindred kind may be derived from the material passed from the bowel. Although the value of such information is limited by the fact that, while the disturbance may be high up in the bowel, the material is not obtained till it has passed along the whole remaining length, and in this time it will have undergone much change. Nevertheless the examination of the motions may yield most important information. In cases where such information seems likely to be valuable, one washes the motions. This is done by mixing the motions in a perfectly clean vessel with water, to every pint of which a tea-spoonful of salt has been added.

The simplest way is to prepare a large jugful of salt and water, to break the motions down with a piece of stick, then pour on plenty of the salt and water. Stir and then allow to settle. In a short time, half an hour or so, gently pour off the coloured water, again break down any masses left, pour on again plenty of the salt and water, and again allow to settle. Repeat this till no coloured material remains to stain the water. The remnants, which are usually small, can then easily be examined, and it will surprise many to learn how easily its constituents may be identified. The process, it may be remarked, is perfectly inoffensive, provided large quantities of salt and water be used. As soon as the motions are well covered with salt and water, smell ceases to be given off, and no one who did not know could tell, by appearance or smell, whence the undissolved residue had been obtained, if it has been properly washed. In it it is quite easy by the naked eye to identify apple-pips, fig seeds, grape seeds and skins, grains of undigested oatmeal, undigested fibres of meat, pieces of banana, uncooked apple, and so on.

Not seldom will such a process reveal the mischief going on. In mucous disease of the bowel flakes or large pieces of mucus, like skin, are the evidence of a chronic catarrh of bowel. Clumps of thread-worms, or portions of tapeworm, are easily identified, and under the microscope the eggs of intestinal worms may be detected. While mucus in any quantity would point to an irritation of the bowel, the presence of parts of worms would suggest the possible cause, or, in the absence of anything else, quantities of fruit seeds, orange peel, pork rind, oat grains, or wheat husks would suggest merely errors in diet.

Quantities of undigested meat fibre hint at either excess in the consumption of meat, or want of power of the digestive juices to deal with it.

Of course at the very beginning of such a washing process one could not fail to notice, what so many people who suffer from marked bowel symptoms never think of observing, the colour of the motions, whether claylike from lack of bile, tarlike from presence of altered blood, or frothy and yeasty because of intestinal putrefactive change. In the same circumstances, too, the shape of the motions will not escape notice, whether of the ordinary full rounded form, or in small hard round masses speaking of delay in passing along the bowel, or flat and ribbon-like, or small like pipe-stems, suggesting a narrowing of the canal of the bowel near the outlet.

In short, in long-continued bowel disturbance, washing the motions affords frequently an immediate clue to the nature of the disease, and, we repeat, the process is easy, and if properly done entirely inoffensive.

The pancreatic juice is most active in the digestion of fat, and when the pancreas is seriously diseased much fat may escape digestion and appear in the stools.

Thus these simple methods of observation, when combined, will have yielded much information as to

(1) The presence or absence of swellings or growths and the part of the bowel involved.
(2) The locality of pain.
(3) The activity of the intestinal juices.
(4) The presence or absence of bowel irritation.
(5) The occurrence of fermentation in the bowel.
(6) Deficiency or not of bile.
(7) The digestion of fat.
(8) Whether there is delay in the passage of the waste along the bowel.
(9) Errors of diet.
(10) The presence of worms or other foreign matters.

THE GENERAL TREATMENT OF BOWEL DISORDERS.

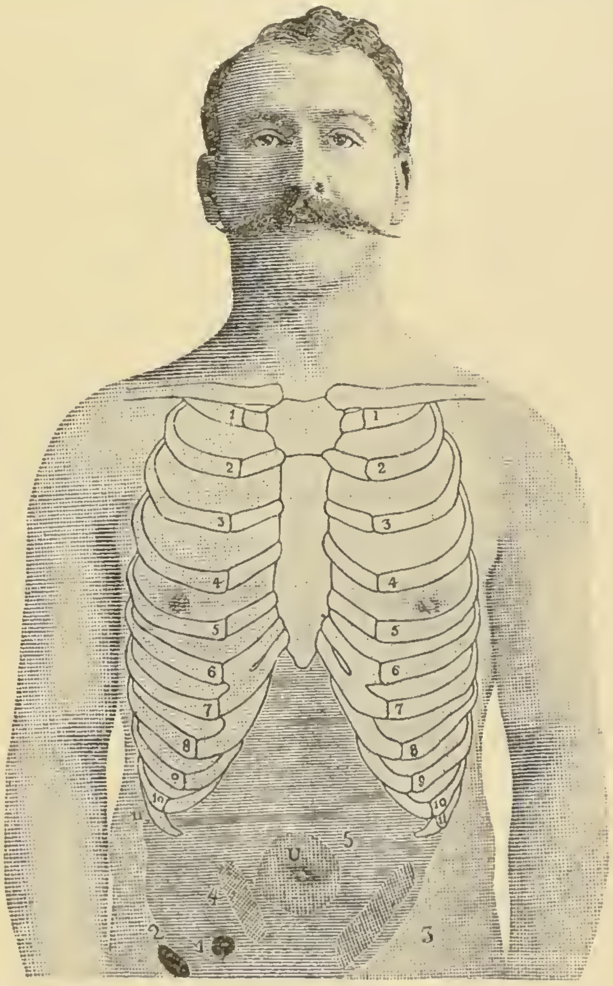


Fig. 113.—Usual Seats of Pain in some Disorders of the Bowels.

Pain diffused all over abdomen, represented by cross shading, suggests general peritonitis. 1, Appendicitis. 2, In women right ovarian pain, pain in a similar region of left groin, irritation of left ovary. 3, Neighbourhood of termination of large bowel. 4, Frequent region of pain from passage of stone from right kidney apt to be confused with appendicitis. Stone from left kidney might produce pain in similar position on the left. 5, Colicky pain in small bowel. U is the umbilicus or navel.

The great variety of bowel disorders makes it difficult to lay down rules apart from the consideration of particular diseases. It will be apparent, however, that any disorder of the bowel will be markedly affected by the kind of material passed into the intestinal canal from the stomach. Many affections of the bowel persist because they do not at once affect the appetite, and, the stomach being undisturbed, the patient sees no reason for modifying the diet. When one reflects, however, that all the waste and undigested material from the stomach passes along the bowel, the foolishness of continuing an ordinary diet, when the bowel is disturbed, because the appetite is unimpaired, will be apparent. In the second place it will also be clear that since the food continues to undergo fermentive change as it passes along the bowel, and its waste matters begin to take on a putrefactive process, it is desirable in any bowel disturbance to keep the whole length of bowel as clean as possible, and to hinder the retention anywhere of any such material. That is to say, the two primary things to attend to are (1) the reduction of the diet to the smallest and simplest kind, and (2) the unloading of the bowel. The means for doing this are practically identical with those already detailed on p. 227.

As regards pain and vomiting the general directions given for the treatment of such symptoms in stomach disorder are equally applicable to the present case (p. 229).

We may, therefore, following a similar course to that taken in discussing disorders of the stomach, go on to consider one or two of the chief symptoms in disorder of the bowel, emphasizing the fact that though these symptoms are spoken of as if they were diseases in themselves, they are really only indications, though the most prominent ones, of a bowel disease.

SOME VARIETIES OF BOWEL DISORDER AS INDICATED BY THE NATURE OF THE CHIEF SYMPTOM.

We have already seen that as regards the bowel itself its chief disturbances, so far as digestion is concerned, centre round the amount and character of the fluid secreted by its walls, and the peculiar movement by which it propels its contents along in the proper direction. The most obvious disturbance of the former is when, by irritation, it becomes excessive and mucous in character, giving rise to loose, fluid or semi-fluid motions, and of the latter when it becomes sluggish, so that evacuation of the bowel is delayed or arrested. A third symptom is pain of a peculiar character, cramp-like pain, due to the peristaltic movement becoming excessive and spasmodic in limited parts of the tube. Thus we have the three chief affections associated with indigestion in the bowel:

Diarrhœa, Constipation, Colic.

Diarrhœa.—This term is derived from a Greek word *diarreo,* meaning to flow through, and is applied to the condition in which the stools are frequent and watery.

Its causes are various. Some food that has been taken may not agree, may irritate the mucous lining of the stomach and bowels, and cause an excessive secretion of the intestinal juices, or may stimulate the bowels to too energetic contraction. The presence of worms will act as an irritant. Similar results may be brought about by the catarrhal condition already described (p. 214) as producing the copious discharge from the nostrils, throat, &c. Thus the condition so well known as "cold-in-the-head" may have its likeness in a catarrh of the bowels. Emotions of various kinds may produce diarrhœa, the "*diarrhœa a timore*", looseness from fear, for example. In many women of a hysterical tendency the least excitement will provoke the flux. A kind of nervous diarrhœa is common in women about the time of the "change of life," and is accompanied by flushings and sweatings. It should not be forgotten also that an irritation applied only to the anus or lower part of the rectum may determine a flux from the large intestine above and even from the small intestine. This is undoubtedly because of the nervous communications distributing, so to speak, over the whole bowel the effect of an irritation experienced at one part of it. This explains how piles produce griping and diarrhœa. Further, it is necessary to remember that articles of food, ordinarily quite easily digested, will produce indigestion, griping, and looseness of bowels in some. Thus Trousseau says: "I knew a man who suffered from diarrhœa for years, notwithstanding the trial of every sort of treatment, and whose general health was seriously impaired by the affection. The symptoms disappeared, as if by enchantment, upon the patient, of his own accord, discontinuing tea for breakfast, which for twelve years he had been in the habit of taking. I attended the family of a ship-builder at Havre whose children were unable to tolerate milk for the first seven years of life. A few mouthfuls of any kind of milk at once caused diarrhœa and vomiting." It must also be noted that diarrhœa is a common symptom in various diseases, in chronic inflammation of the bowel, in diseases of the liver and spleen, in typhoid fever, in tubercular disease of the bowel. (See CONSUMPTION OF THE BOWELS, p. 254, &c.)

Symptoms.—Besides purging, sickness and vomiting occur, and there are loss of appetite, furred tongue, and thirst. In most cases also griping is a feature, flatulence, and belching. Where the pain is severe, the person may be much prostrated; his skin may be cold and pulse feeble. In what is called **summer diarrhœa**, or **English cholera**, the attack is often occasioned by errors in diet, by eating tainted meat, unripe fruits, herrings, &c., and begins suddenly with vomiting, which is frequent, and speedily accompanied by purging. Pain across the belly is severe. The irritating nature of the discharge causes a constant feeling of need to go to stool, which the patient would fain not do because of the painful straining that ensues. What passes is very watery, and contains often bile-colouring matter. The vomit is generally, after a little, also coloured with bile, because the retching has forced bile into the stomach from the small intestine. The patient speedily becomes seriously weak, cold, and complains of cramps in the limbs, and the features are pinched and sunken. A similar form attacks children, and is called infantile diarrhœa. It is spoken of under DISEASES OF CHILDREN. **Lientery** is the term applied when the stools that are passed consist largely of undigested food. It indicates excessive action of the intestinal wall, and that the food has been hurried through the bowels. This shows how the character of the motions may afford valuable indications of the nature of the attack. Thus if the early motions are covered with mucus, as with a coat of gluey-looking material, this indicates excessive secretion and intestinal irritation.

The treatment of diarrhœa should not proceed on any rule of thumb, but the person should try to make out whether the probable cause is *connected with the diet* or *catarrh* (cold), or *the presence of an irritant*, or *excessive action of the intestinal coat*, or *nervous*, and treat accordingly.

In the case connected with diet, altering the food, and exercising watchfulness in the matter of eating and drinking, is probably all that will be necessary.

If the attack be dependent on a chill, let the patient rest, and restrict the diet to milk as directed on p. 227. If medicine be necessary, a saline purgative should first be taken early in the morning, a dose of seidlitz-powder or rochelle-salts. If, after the action of the salts, the diarrhœa does not abate, then let the subnitrate of bismuth be taken in combination with prepared chalk, 20 grains of each, several times a day. If these fail, 5 grains of the compound ipecacuan powder should be added to the dose.

If irritation of the intestinal canal is suspected to exist, purgative medicine should invariably be given first, ½ ounce of epsom or glauber salts, or a dose of castor-oil. After the irritant may be supposed to be expelled, the bismuth and compound powder of ipecacuan should be used.

For nervous diarrhœa, and the type called lientery, some preparation of opium is proper. It must be given in small doses, drop doses, 1 to 5 drop doses of laudanum taken before food (*but only to adults*). In the nervous form, 10 to 15 drops of ether may be added to the laudanum. For *summer diarrhœa*, which comes on usually with great rapidity and severity, the treatment consists in keeping the person quite quiet in bed, and in the administration of such soothing drinks as may be expected to some extent to calm the irritated mucous membrane. Chicken-broth seems to answer this purpose well, also iced water, rice-water, barley-water, flour and water. To the same end hot applications, a mustard poultice, a hot flannel sprinkled with turpentine, &c., may be laid over the belly. Ipecacuan powder, and in large doses, 20 grains repeated every two or three hours, is strongly recommended. Stimulants are also required—the ether-and-ammonia stimulant being most useful. (See PRESCRIPTIONS — STIMULANTS.) One is strongly tempted to use opium. If employed it must be with great care. The best way would be to add 5 drops of laudanum to each dose of the ether mixture, and to watch how it acted. It could be repeated every two hours if the patient bore it well, and the dose of laudanum even slightly increased if experience showed it proper in the individual case, or the chalk, catechu, and opium mixture may be given carefully. (See PRESCRIPTIONS—DIARRHŒA MIXT., p. 617, Vol. II.)

The difficulties attending the treatment of summer diarrhœa are, however, so great, and the disease is so rapidly exhausting, that no delay should be permitted in the summoning of a qualified physician. In all cases of chronic diarrhœa also the difficulties of obtaining a remedy are so great that medical advice should be sought so that the details of the particular case may be duly examined into.

It must be noted that nothing is here said about summer diarrhœa of infants, which is treated of under DISEASES OF CHILDREN. It is also necessary to note here that nothing is more dangerous than the administration of laudanum or opium in any form to children. A single drop of laudanum will often throw a child into a stupor for forty-eight hours.

Constipation, or costiveness, is that condition in which the ordinary passage of matters from the bowels is less frequent than is usual, or the quantities passed less in amount than usual. The common rule is that a person should go to stool once a day; but this rule must not be indiscriminately applied. There are plenty of exceptional cases, cases where persons regularly have only one passage in two or three days, with whom a greater frequence indicates something wrong, and who, with the less frequent passage, are in perfect health. With a few people, indeed, once a week is the rule, and there are even cases on record of persons who for years had an interval of several weeks without going to stool, and that without any manifest impairment of the usual state of health. It would, consequently, be wrong to insist that everyone, without exception, should have a daily passage, to be effected by the use of medicine if it did not occur naturally. The question should always be asked: What is customary? If a two or three days' interval has been the rule in the person's life, do not interfere; if the two or three days' interval is a departure from the usual, even though it be a departure which has lasted for some time, efforts should be made to restore what has been customary. There may be various causes for costiveness. It has been seen (p. 239) that the various materials contained in the bowel are propelled along it by contractions of the muscular walls. The contractions are of a remarkable kind, not occurring in the whole tube at once, but passing along it in waves, one region contracting after another. The movement is called *peristaltic*, because it occurs in steps or stages. Now if this movement be very vigorous the food will be hurried along, will quickly reach the rectum, which may in turn as quickly expel it, so that looseness of the bowels is occasioned. On the other hand, if the muscular walls have lost their tone the peristalsis will be feeble and the movement correspondingly slow. Further, as the materials move along, the nourishing and watery parts are removed, and therefore the more slow the movement the more firm and compact will become what is left. In the large intestine the pouches in the wall (p. 199) will offer great difficulties to the advance of the fæces, and so extreme constipation results. It is also clear that, though the muscular contraction of the bowel be efficient enough, if there has been a scanty quantity of secretion from the liver, pancreas, and walls of the intestine, the alimentary materials may be too dry, and their advance will be delayed. Thus deficient secretion into the bowel, especially of bile, or want of tone in the muscular walls, in fact, sluggishness of the intestinal tract, may be the cause of costiveness. Now it is of the utmost consequence to observe that this sluggishness may be determined and developed directly by persons themselves. The feeling of a necessity to go to stool is an indication of peristaltic action occurring in the rectum in the endeavour to expel the material lodged there. If the inclination is resisted, the action, being ineffectual, becomes exhausted; and if this resistance is a daily occurrence the healthy tone of the bowel is lost, both because of the opposition it continually meets, and also because the matters, allowed to accumulate in the rectum and parts above it, distend unduly these parts, and overstretched structures always lose tone. Sluggish action of the bowels is also induced by want of exercise. Many articles of diet are constipating. Every man ought to know for himself what substances act thus on him; but an exclusively animal diet tends to costiveness, while a vegetable diet is the reverse. Very dry feeding is also binding. There are also mechanical causes of constipation, such as are noted under OBSTRUCTION OF THE BOWELS (p. 253).

Women should note that certain misplacements of the womb occasion great obstacles to the passage of the fæces, simply by pressing against and blocking the bowel, and the consequent costiveness seriously aggravates the uterine trouble.

Symptoms.—The main symptom is evident, but others attend it, such as indigestion, want of appetite, headache, dulness, lowness of spirits, and uneasiness about the region of the stomach and bowels. A bad complexion and foul breath are also results.

Treatment.—If what has been said about the causes of constipation has been understood, the treatment will, in many cases, be evident. First of all, the habit many busy men have of delaying going to stool till it suits their business must be stopped. The habit of going to the water-closet at a certain time every day should be adopted. The best time is perhaps after breakfast, at any rate after a considerable meal. This may be vain at first, but, if persisted in, will in the end be beneficial. If this is not effectual it may be assisted by means which rouse the contractions of the bowel. Of these one very successful is the injection, by means of an elastic ball, of a quantity of tepid water and then of cold water. This, repeated for two or three days at the same hour, will in very many cases be sufficient. This form of treatment may be aided in various ways by the use of vegetables and fruits at meals, provided they otherwise agree, and ripe fruits in the morning, figs, prunes, &c., the use of bran bread instead of fine white bread, the drinking of a tumbler of fresh water on rising, or on going to bed, &c. &c. Many men find that if they do not smoke a pipe or cigar after a meal constipation results. Along with the use of such means exercise must be regularly taken.

Should these measures fail Trousseau recommends the use of a pill of $\frac{1}{6}$th grain of belladonna taken daily before breakfast. Two may be taken together at the beginning of their use, if necessary, but they are to be discontinued as soon as possible. In many cases where the liver is slow a pill of $\frac{1}{3}$th grain of the resin of podophyllin and $\frac{1}{6}$th grain of extract of nux vomica is effectual when taken before breakfast. Brisk purgatives should be avoided as long as possible. If necessary, however, the best purgative is castor-oil, which may now be obtained in gelatine capsules for those who could not otherwise take it. Sometimes purgative medicines fail to give relief because hardened fæces have been allowed to accumulate in the rectum. The proper treatment for this is the injection of a strong stream of soapy water by means of an enema (see Plate XXXII, and p. 407, Vol. II.) till the hardened mass becomes softened and loosened. Finally, a drug has lately been introduced for obstinate constipation, the Cascara sagrada, the bark of *Rhamnus Purshiana* from the North Pacific coast. It may be taken as extract, 2 to 8 grains in pill, or as fluid extract, of which the dose is 10 to 60 drops. It has a very disagreeable taste, and a cordial has now been made to disguise the taste, of which 15 drops to one tea-spoonful is a dose. The quantity that is found necessary in each case should be taken and gradually reduced till it can be stopped altogether. It may also be obtained in tabloid form, alone or in combination with aloes and other stimulants of bile.

In women during pregnancy constipation is often very troublesome; for this nothing is better than a wine-glassful of Hunyadi Janos mineral water every morning before rising.

Colic is another symptom of intestinal derangement which requires special mention. Pain, as has been seen, is a frequent symptom in dyspeptic conditions. In colic the pain is experienced across the belly about the region of the navel. It is due generally to irregular and spasmodic contractions of the large bowel—the colon, hence the word colic. The pain is of a severe twisting character, and comes on in paroxysms, occasionally so severe that the patient rolls and twists about, usually doubled up and grasping his belly, crying and groaning like one bereft of reason. Constipation of the bowels is usually present, and the pain may occasion vomiting. Often, however, severe colicky pains are the forerunner of looseness of the bowels, caused by some food which has disagreed. The pain may be caused by wind, the discharge of which greatly relieves. There is no fever with the attack, indeed the pulse is usually lowered, and the face pale and anxious looking. This helps to distinguish colic from an inflammatory attack. Another great distinction is that pressure on the belly relieves, while, if the pain were due to inflammation, pressure could not be endured. The attitude of the person and the pressure he himself exerts with every renewal of the attack show that it is not an inflammatory affection that is the cause of the disturbance.

The passage of a gall-stone or a stone from the kidney—biliary or renal colic—is not to be confounded with this affection. (Refer to DISEASES OF LIVER OR KIDNEY.) Lead colic is discussed under LEAD POISONING. (See INDEX.)

Treatment.—Let hot cloths or bags of hot salt be applied over the belly at once, and let a full dose of medicine be given, castor-oil or some such simple medicine. A large injection of water at a gentle warmth will probably bring relief. Along with the castor-oil, or a short time after it, may be given (*to an adult*) 15 drops of laudanum.

SPECIAL AFFECTIONS OF THE BOWEL.

Inflammation of the Bowels (*Enteritis, Catarrh*).—There are several forms of inflammation of the bowels of great severity and very fatal. One form, which will be described here, is not so serious, and partakes rather of the nature of catarrh, as described in connection with the stomach. Instead of being called inflammation of the bowels it ought rather to be called **intestinal catarrh**. As has been already noted (p. 214), catarrh, beginning in the nasal passages, may pass to the throat, onwards to the stomach, and may also pass from the stomach to the remainder of the alimentary canal. Further, even as irritating substances may produce catarrh of the stomach, so may catarrh of the small or large intestine be occasioned. There can be no doubt that improper food may occasion it, specially in children, who seem liable to it at the period of teething. In children the disease is apt to be very severe, and to prove fatal, from the speedy exhaustion of the child. (See DISEASES OF CHILDREN.) It is not doubtful that in the summer months the use of herrings and new potatoes, as well as the eating of overripe fruits, has been a very frequent cause of such catarrh of the intestinal tube. It is the mucous lining of the intestines that is affected, which becomes swollen and congested, and pours out a copious secretion of mucus. Like catarrh occurring in other situations the disease may be acute or chronic.

The **symptoms** of this form of inflammation are uneasiness or positive pain and griping in the bowels, sickness, vomiting, and purging. The vomiting and purging are sometimes very severe. The vomit is mucous, and later bilious, giving rise to the idea that it is a bilious attack. The discharge from the bowels is mucous or watery and irritating, and very abundant. What is worse is the straining at stool, and the frequent desire to go to stool without any result. Accompanying these, which are often the first symptoms, are fever, which may even reach 103°, furred dry tongue and foul breath, loss of appetite, and severe headache. The skin is also dry and burning. It is important to note that while the belly may be tender there is no great pain on pressing it, and no particular spot specially painful. This, among other things, distinguishes the disease from a severer form of intestinal inflammation, and from peritonitis, which will be described later.

Treatment.—If the catarrh is due to some irritating substance, then the purging, &c., is to some extent an effort of nature to expel it, and in such circumstances a moderate dose of castor-oil as a preliminary would doubtless be beneficial. It should be followed in about an hour by a dose of ipecacuanha and opium in the form of Dover's powder, 5 grains (*for adults only*), and this dose may be repeated, as seems desirable, every three or four hours till the purging and vomiting cease, when its administration should stop, an occasional dose being given should the griping and purging seem about to return. With the Dover's powder 10 grains of bismuth may be conjoined. It often happens that no sooner is a powder given than it is vomited. In such a case the use of ice is wonderfully relieving. The patient may be allowed to suck small pieces of it, or may be allowed sips of iced milk. When the irritability of the stomach is in this way allayed a little, a second powder may be given. A warm application to the belly is also very grateful to the patient. Accumulations of wind often distress the person and occasion colicky pains. For these, as well as for a stimulant, when the first acuteness of the attack has passed, a tea-spoonful of the ammonia-and-ether mixture (PRESCRIPTIONS—STIMULANTS) may be useful. Should the person become faint the brandy-and-egg mixture (see PRESCRIPTIONS—NOURISHING MIXTURES, &c.) should be used. Stimulants, however, are not to be employed, as is too often the case, as a matter of course, but only if really necessary. As to food, the iced milk will be sufficient at first. Later, mutton broth rid of fat, bread and milk, &c., should be given. When the attack is over, the patient is generally very weak, requires good nourishing food, and tonics such as that of quinine and iron.

Chronic catarrh of the bowels is usually accompanied by vague discomfort round about the navel, if the catarrh involves mainly the small bowel, and across from right to left if the large bowel is chiefly concerned. There may be diarrhœa, if the disordered state is near the lower end, but if the catarrhal condition be high up in the small bowel, diarrhœa may not appear. There is often a feeling of sickness (nausea) though no vomiting, and this feeling is distressing by its persistence, and seems to have its seat between the navel and lower margin of the ribs. The back part of the tongue is usually white and coated, and the appetite is uncertain. There is usually also much formation of gas, and gurgling or rumbling noises may be common.

One of two kinds of diet may be tried. The exclusive milk diet may first be used, the milk being boiled if there are loose stools, and consumed with rusk or stale white bread, such a meal being taken every 3 or 4 hours. In some cases, however, milk does not suit at all, and then an almost exclusive meat diet, with white-of-egg drink, may be used. The meat is scraped and steamed for a few minutes only, and eaten with the thinnest and crispest of toast. For thirst, the white of one egg is stirred in 1 pint of cold water, and strained through a cloth. This drink is taken between the meat meals, which should be 3 daily, with 5-hour intervals, about 4 oz. of meat, of beef or chicken, being taken each time. Tonics of iron, quinine, and strychnine may be taken. If there is much mucus in the stools, the bowel should be daily washed by the injection of 3 pints of warm water containing in solution 3 tea-spoonfuls of table-salt.

Mucous Catarrh of the bowel (*Mucous Colitis, Membranous Colitis*) is a disease of the large bowel (*colon*) in which large quantities of mucus are passed in the motion. The mucus is in skin-like masses, coating and being mixed with the stools. In typical cases the mucus is not passed in every stool, but periodically there is an attack of what the patient calls diarrhœa, which commences with more or less severe griping pain, followed by a copious loose motion containing masses of mucus. This may recur regularly every two, three, or four weeks, and in the interval the patient suffers from constipation.

The subjects of this disease are usually women who are nervous and excitable, but it also occurs in children, and the author has met with one case in a child where it was the cause of attacks of an epileptic character.

The regulation of the diet, overcoming the constipation, washing of the bowel, the use of iron and nerve tonics, are the methods of treatment. The disease is troublesome, may last for many years, but is not grave.

Appendicitis (*Typhlitis, Perityphlitis*) is an inflammation of the appendix, the small appendage to the commencement of the large bowel. Refer to fig. 99 and to Plates XII. and XIII.

The appendix may be merely inflamed, more or less acutely. While the inflammation is in progress it will be swollen, and while inflamed it may form adhesions with the bowel or other neighbouring parts. The inflammation may subside, leaving the part somewhat thickened and adherent. The inflammation may go on to suppuration, matter being formed. If the process has been slow, adhesions may have formed all round the appendix, inclosing it and shutting it off from the general cavity of the bowel, so that the matter is inclosed in a kind of sac, a localized abscess is formed, that is to say. But the process may be so rapid that this has no time to occur, the matter infects the general cavity of the abdomen, and a diffuse peritonitis arises of a most acute and rapidly fatal type, or the inclosed abscess may, by some sudden effort, be burst, the matter again infects the abdomen, with a like result.

Now this process may be caused by decomposing portions of food retained in the part of the bowel with which the appendix communicates. It may be due to larger particles, such as seeds, scraps of bone, lodging where the fine canal of the appendix opens off the cavity of the bowel, and the process may originate in a small wound of the mucous membrane, or ulcer so caused. Concretions sometimes form in the bowel, and they may form in or near the canal of the appendix, which, by their gradual increase in size and their pressure, ulcerate their way through the appendix and escape into the cavity of the abdomen, the disease manifesting no premonitory symptoms till the appendix is suddenly broken through. Sometimes the outbreak is due to a constriction or narrowing of the fine canal of the appendix, causing secretion to be retained within it, which gradually accumulates till the wall is thinned down and leakage takes place. As soon as this leakage occurs the abdomen becomes infected and an acute inflammation arises.

By such a constriction or by the formation of a concretion the blood supply of the appendix may be so hindered that gangrene of the appendix may occur, and when the gangrenous process is sufficiently advanced, the infection of the abdomen occurs. The acute and grave forms of the disorder, then, are always due to an infective process, material from the bowel leaking into the cavity of the abdomen, such material containing organisms to which the infective process is due. Such leakage, however, can only occur when the integrity of the walls of the appendix is impaired in some one of the ways mentioned, or others similar.

But an attack of simple inflammation of the appendix may have as a result thickening and hardening of the appendix walls and obliteration of its fine canal. Such an attack, going no farther, and recovered from, may be a safeguard to prevent the grave form of the disease, the walls of the appendix, by the adhesive inflammation on their surface, being less pervious than before. This might not prevent succeeding attacks of inflammation, but hinders them going on to produce leakage and infection of the general abdominal cavity. This is doubtless the explanation of some cases at least, where there are frequent recurrences of inflammation never assuming a grave aspect. In such cases, if an operation be done, the appendix is found thick and generally larger than usual, and in most cases adherent, but there is no sign of purulent infection.

Thus changes may be going on within the appendix, producing no obvious symptoms until the stage is reached when the parts in the immediate neighbourhood become involved, and the acute illness bursts forth. An abscess may have formed, or the appendix may be gangrenous, and there is no sign till suddenly the abscess bursts or the gangrenous wall breaks down, and disaster becomes imminent.

Symptoms.—The chief symptom is pain, usually severe, sometimes excruciating. It is usually located at a spot in the neighbourhood of the right groin, midway between the point of the haunch bone and the navel, and in a straight line up from the centre of the groin. It is cutting, tearing, stabbing, and is increased by movement and aggravated by the slightest pressure over the spot. It is usually persistent, with colicky spasms. This spot is shaded in Fig. 112. If the hand be laid over this region the muscles underlying the skin will be felt to be rigid, and the patient involuntarily guards the place. There is fever, and hot, burning skin. It is often possible to feel the swollen appendix, and if there is an abscess it may evidence itself by a slight fulness of the abdominal wall. Vomiting is a frequent symptom, specially at the onset. The fever may be moderate or high, and the pulse is quickened in proportion. The breathing is short, due to holding of the abdominal muscles. The patient is frequently unable to pass urine, and constipation is common.

In cases where changes have been quietly going on, leading to abscess or gangrene, few symptoms may arise, till the abscess bursts or the gangrenous appendix breaks down. This is indicated by sudden violent pain, producing faintness and vomiting, then a shivering fit (*rigor*) occurs, and high fever, with quick rattling pulse, supervenes.

If the position of the appendix were constant, the difficulties surrounding the diagnosis of appendicitis would not be so great as, unfortunately, they are. But the appendix—with, of course, the portion of bowel to which it is attached—may be situated at a considerable distance from its usual position. It may be nearer the middle line, or really over to the right side, and it may be down in the pelvis. In such cases no pain is likely to exist over the usual locality, and so the true nature of the malady is for a time concealed. When the appendix is deep in the pelvis the patient may have difficulty in pointing to the exact seat of pain, and his hand may wander vaguely down to the lower part of the abdomen when he is asked to show where the place is. Besides this, pain is sometimes felt in other parts quite remote from where the diseased appendix is, the pain being referred to the region of the navel or higher up at the "pit of the stomach."

When, however, anyone complains of abdominal pain, he should not be asked to describe where it is. Most people will say in the stomach, because they do not know the exact location of this organ. The person should be asked to lay his hand on the place, and if he places it anywhere near the right groin, suspicion should be aroused at once.

Attacks of simple inflammation may subside in a few days. But if the pain persists and spreads, or if the temperature goes higher and the pulse becomes rattling, or if swelling appears, or the whole abdomen becomes full and tense, the condition is very grave.

Treatment.—The patient should be kept strictly to bed, not being allowed up for any purpose whatever. Diet should be restricted to small quantities of diluted milk; for the first day or two it does not matter though no food be taken at all; water may be given in sips, or chips of ice.

The bowels should be thoroughly cleared out, by a full dose of castor-oil preferably. But if the pain is too acute to risk moving the bowels in this way, they may be cleared by an injection of oil and soapy water. As soon as this has been done, opium in some form should be given, probably $\frac{1}{6}$th grain morphia suppository passed into the bowel would be best, or 10 drops of the liquor morphia, with 7 grains antipyrin, may be given by the mouth, and repeated every two hours till some relief is gained, and thereafter not oftener than is needful to maintain some degree of comfort. Warm applications may be applied to the abdomen, but nothing that can damage the skin, as that would interfere with any operation that might become necessary.

If the attack passes, food must be given very sparingly, and very cautiously increased, the opiate should be stopped, and tea-spoonful doses of castor-oil given several times daily till the bowel is got to move. When the attack is over, many people believe in the value of saline aperient medicine taken early each morning. As to operation, it is sufficient to say here that it should be performed without delay if there is reason to believe abscess has formed, but the operation for removal of an appendix that has given trouble should only be undertaken in the interval between attacks, not when acute symptoms are present.

Dysentery (*Bloody Flux*) is an inflammation of the large bowel, and specially its lower end. The mucous lining of the bowel becomes intensely congested and, if amendment do not occur, ulceration ensues. Patches of the mucous membrane die and become detached, leaving ulcers. Thus a great extent of the large intestine may become stripped of its mucous membrane and ulcerated. Should recovery take place and this heal, it is at the risk of narrowing and seriously contracting the tube.

Dysentery is not common in Great Britain. It is most common in tropical countries, and specially where the land is low and swampy. It is the plague of armies in the field. It has been supposed to be due to wet and cold succeeding great heat. No doubt bad food, bad air, and specially bad drinking-water are powerful causes in determining its occurrence. It is not infectious, that is to say one may nurse dysenteric patients without running the slightest risk of "catching" the disease from them. It is not certain whether it is contagious, whether, that is, any of the discharges of patients getting into a water supply, for example, would be likely to give rise to the disease in those who drank of the water. It occurs in districts where ague is common, but does not seem to depend on the poison of malaria, since it is common where there is no risk of malaria.

Its symptoms are as follows: a patient who for a short time previously may have felt "out of sorts," or have been feverish, with hot dry skin and clamminess of mouth, is suddenly seized with diarrhœa and passes a large loose stool. Soon after he has a great desire to go to stool again, and becomes tormented with the feeling of something requiring to be dislodged. He sits straining at stool, discharging only small quantities of mucus—glairy transparent material. The painful straining (**tenesmus**) and burning pain about the anus are characteristic. The discharge is frequently mixed with blood, and contains no fæcal matter, properly so-called, except a small quantity which occasionally comes away in little hard lumps. This distinguishes diarrhœa from dysentery, since in the former the discharge is mainly of fæcal matter, though liquid. There is, therefore, in dysentery really retention of the fæces. There are also tormenting pains of the bowels (**tormina**). After eight days or more the stools become very offensive, cease to be mucous, and have the appearance of flesh washings with shreds floating in them, like fragments of overstewed meat. The patient in severe cases is highly fevered, flushed, with foul tongue, headache, and thirst. He suffers from flatulence, and has pain in making water, which is scanty and high coloured. Extreme prostration with faintness, weak pulse, hiccough and vomiting, and a feeling of sinking at the heart indicate a fatal termination to the disease. Cases that recover begin to mend about the sixth or tenth day, the straining being diminished as well as the frequence of the stools. The acute disease may pass away, leaving a chronic affection, the patient suffering constantly from colicky pains and loose stools, with tenderness of the belly, till, months or years after, he may succumb to disease of the liver induced by it.

Treatment.—There has been much controversy as to the appropriate treatment for dysentery, calomel, opium, ipecacuan, and various other remedies having their advocates. Trousseau, the distinguished physician of Paris, who bases his method upon observations of several epidemics of the disease, describes his treatment as follows: "At the beginning of the attack I prescribe ipecacuan in emetic doses—46 grains are divided into four powders, one of which is taken every ten minutes till vomiting is induced. Next day, and often even on the evening of the same day in which the ipecacuan has been thus administered, I give one of the neutral salts (sulphate of soda, sulphate of magnesia, that is, epsom-salts, or rochelle-salts) in a dose of from ½ ounce to ¾ ounce, which ought to be repeated during the following twenty-four hours. I go on giving the saline medicine till there is an evident change in the nature of the stools, or in other words till they cease to contain glairy bloody matter and become of the nature of diarrhœa stools." He also during the same time injects into the bowels by means of a syringe, a solution of 15 grains sulphate of zinc in 7 ounces of water, keeping the solution in the bowels as long as possible. He strongly objects to the improper use of opium, employing it only for checking pains and vomiting, and then giving only drop doses of laudanum every hour till the pain or vomiting is relieved. For diet the patient gets barley-water, rice-water, or toast and water, and thin broths. The liquid extract of the Indian Bael fruit has been much recommended, in doses of one to four tea-spoonfuls. In chronic cases the patient should wear flannel round the belly, should use simple diet, milk, eggs, &c., no vegetables, and take iron and quinine tonic. An injection of tincture of witch hazel (*Hamamelis virginica*) may be tried, a tea-spoonful of tincture in 3 ounces of water to be injected and retained.

Cholera (*Epidemic Cholera, Asiatic or Malignant Cholera*) is properly an acute contagious disease, a general disease perhaps, and not simply a disease of the bowels. It might properly have been classed under other acute infectious and contagious diseases, but it will be convenient to consider it alongside of diarrhœa and dysentery, with which it has so many things in common.

Cholera first appeared in Great Britain in the autumn of 1831, beginning at Sunderland. In the following year it reached America, attacking Quebec. The disease had travelled all the way from the Delta of the Ganges, where it broke out in 1817, and from which it spread all over Asia and entered Europe through Persia in 1829, reaching Russia and Poland in the spring of 1831, and England a few months later. It thus took fourteen years to travel from India to England, but its progress though slow was sure. It came by no unknown and deserted pathways, but by the highways, and along the paths of human intercourse. In fact there is no doubt it did not travel alone; it was brought, carried from place to place by caravans, by ships, by bands of pilgrims. In 1848–49 it again appeared in Britain, again in 1853–54, and in 1865–66, carried to the country in each case by persons, passengers or sailors, who had come from some infected region in the East. For, though the outbreak of 1817 in India was the first of consequence to Europeans, the disease appears to have been common in India centuries before that

It is a very fatal disease, causing the death of about 50 per cent of those whom it attacks. It kills with great rapidity, sometimes in two or three hours, in many cases within twenty-four. It spreads with frightful rapidity. In 1853–54 it had in England 70,000 victims.

For such reasons as these the mention of cholera provokes a panic; yet in the eyes of reasonable men it should not. For cholera can be grappled with perfectly successfully, but only in a certain way. Its immediate cause is yet obscure. The epidemic in Egypt of 1883, which reached France in the summer of 1884, led to careful investigations being made in Egypt, India, and France by distinguished English, German, and French experts. Dr. Koch of Berlin, one of the most able of the investigators, believes he has succeeded in finding its special cause in what is called a *bacillus*, which he has found in the intestines and in the discharges of all cholera patients. Bacillus is derived from a Latin word *bacillum*, meaning a little stick, and is a very minute rod-shaped body, discoverable only with the aid of very highly-magnifying microscopes. There are various forms of these rod-shaped bodies, one supposed to be the cause of splenic fever, another of intermittent fever. Another was discovered by Dr. Koch in the spit of consumptive patients, and is supposed to have something to do with causing consumption; and now the same scientist believes cholera to be produced by another form, which he describes as like a comma (,). These bacilli are considered as likely to be the germs of disease, the minute seeds, which, when introduced into the body, if they find it suitable, begin to multiply with extraordinary rapidity in the blood and other fluids, and occasion the symptoms of the disease. Just as one must plant oat seeds to grow oats, and wheat seeds to grow wheat, and potato seed to cultivate potatoes, so it is held must the germ of a disease, the special bacillus of the disease, be sown in the body and take root there and flourish before the person can suffer from the disease.

Now there are two things of great consequence to note here in connection with such a view. The first is, you cannot have cholera unless cholera seed has been sown; and the second is, that cholera seed may be sown, but the soil may not be favourable for its growth, and it may not develop. In other words a person cannot have cholera unless he has somehow or other been infected by cholera poison obtained from a previous case of cholera; and a person may be exposed to the cholera poison, but may not suffer from the disease because he is not suitable for its development, because he is not a fit subject for it. Let us see what these things mean. Suppose a person to be plagued with weeds in his garden, and to be anxious to get rid of them. He would watch for their springing up, and would remove them as soon as they appeared. He would never let them come to seed and let the seed be scattered, for he would know that that ensured a bigger crop very speedily. If perchance one escaped his eye, and he noticed it only when it was in seed, he would not be content with pulling it up and throwing it down where the wind might scatter its seed. He would take care to destroy the seed entirely by burning or in some such way. Now cholera is produced by some poison, which to all intents and purposes is the seed of the disease; it may be that Koch's bacillus is the actual seed, it may not be so. At any rate cholera is produced in a person by a poison which has obtained entrance to his body in food, drink, and so on, and it multiplies in his body. Equally certainly is the poison contained in the discharges which come from the patient.

Now suppose the discharge is carelessly thrown on to the land in the neighbourhood of a well, and that some of it enters the well, the cholera poison multiplies fast in water, and the well soon swarms with the seeds of the disease, which nevertheless the unaided eye cannot see nor the taste suspect. Everyone who drinks of that well is liable to be seized with the disease, because the germs are present in the water. Thus it is that cholera spreads. It has been clearly shown that filth, uncleanliness of every description, is most favourable to it. Specially have those towns been ravaged with it whose drinking-water was impure. Therefore a town, which derives its water supply from a river into which it also discharges its sewage, occupies a very dangerous position, unless the supply be taken from very high up the river, out of all possibility of being reached by the sewage. This was well shown in the London epidemic of 1854, where the people, supplied by one water company with water taken from the river too near the city, were attacked by the disease far more fiercely than people, supplied by another company with water taken very much further up the river, although the people lived in the same district and even the same streets.

That the discharges of patients suffering from cholera contain the cholera poison has been shown by experiments on mice fed with some of the discharge. The mice were rapidly killed by an affection resembling human cholera. The experiments, however, showed this remarkable fact, that the discharges from the cholera patient that had stood twenty-four hours were far less poisonous than those that had stood two days. The discharges that had stood three days were extremely poisonous, every mouse fed with any dying. On the fourth day their fatal character was diminished, and later than five days after being passed the discharges had lost all poisonous qualities, so that of mice fed on them after the fifth day none died. If, therefore, steps were taken to destroy all discharges from cholera patients immediately after they were passed, all risk of cholera being communicated to others would be removed. Cholera, it thus appears, can be stamped upon, if those suffering from the disease are kept scrupulously clean, and if the utmost care is taken that nothing, that can contain any germs of the disease, is permitted to pass from his room without being immediately submitted to the action of some agent that will prevent them developing their poisonous properties. How that may be done is considered later on in what is said under treatment.

Now about the second point, the necessity of the cholera seed finding suitable soil. Just as certain kinds of soil cannot support certain plants, so certain people seem able to resist disease. Everybody has a certain power of resisting disease. There is no better preventive of disease than the possession of vigorous health, and due care of it when possessed. A man may, however, diminish his resisting power and lay himself open to attack from any side. There are, therefore, certain things that help cholera, that tend to make a person more suitable for its development within him. These are personal uncleanliness, the use of bad, unwholesome, or insufficient food, or anything which weakens the system, *and, above all, intemperance.* It seems certain that cholera has specially easy prey among those who are addicted to the constant and improper use of alcoholic drinks. *It was observed that in the epidemic in Warsaw, "90 per cent of the deaths occurred amongst those who used alcohol freely."* Further, alcohol is believed to be "*one of the most dangerous agents that can be used for the cure of the disease.*" It is well that this should be prominently stated in view of the fact that some, knowing nothing of the disease, have advocated that as soon as a person suspects he is about to be attacked by cholera, he should drink alcohol till a condition of complete intoxication is produced.

Symptoms.—Sometimes the patient is suddenly stricken down and dies collapsed within a few hours without diarrhœa or vomiting. Frequently the person may feel unwell for a few hours, or a day or two, and low-spirited, suffering from diarrhœa. When the attack begins, the patient suddenly requires to go to stool and passes a large loose motion, just like that of diarrhœa. Thereafter there issues from him an almost continuous stream of a thin whitish liquid with flaky particles in it. It has no smell of fæces, and is the characteristic discharge of cholera, being called from its appearance the "rice stool of cholera." An enormous quantity of this liquid is passed. A little later vomiting comes on, at first of the contents of the stomach, with perhaps bile, but soon of the same rice-water liquid that pours from the bowel. Severe muscular cramps in the thighs, calves of the legs, and belly come on shortly. Following the first stage of diarrhœa and vomiting is the second, the *algide* stage (from Latin *algeo*, to be very cold), or collapse stage. The "term *collapse* expresses a general condition, made up in the most exquisite cases of the following particulars:—A remarkable change took place in the circulation, and a striking alteration in the appearance of the patient. The pulse became frequent, very small and feeble, and at last, even for hours sometimes, extinct at the wrists. The surface grew cold, and in most, or in many instances, blue as well as cold. The lips were purple; the tongue was of the colour of lead, and sensibly and unpleasantly cold to the touch, like a frog's belly; and the breath could be felt to be cold. With this coldness and blueness there was a manifest shrinking and diminution of the bulk of the body. The eyes appeared sunk deep in their sockets, the cheeks fallen; in short, the countenance became as withered and ghastly as that of a corpse. The voice became husky and faint." There is suppression of urine, and the diarrhœa and vomiting also disappear at this stage. The intellect is unaffected and the patient wakeful. Death may occur in from two to fourteen hours, and usually within twenty-four. If death do not ensue, the third stage—the stage of reaction—sets in. The patient shows some signs of improvement in everything, colour, pulse, temperature, breathing, &c., till the former symptoms give place to those of fever, hot skin, quick pulse, flushed face, and perhaps delirium. This condition may last several days, and then the patient may begin to recover, or the fever may end in death by exhaustion, or from affections of lungs, brain, kidneys, &c. The case may, however, present varying degrees of severity, recovery beginning after the first stage without previous collapse, or after the second without any fever of reaction.

Treatment.—It is impossible to state any treatment for cholera, so many methods have been tried, and all of so little avail. Diarrhœa should never be neglected—not in any case, but still less during cholera times, or when chances of cholera are present; it may be merely the forerunner of the more serious disease. The patient, of course, must be kept quiet in bed, and may be allowed to suck ice or to sip iced water. At the outset lead and opium should be given. They are best given in pill, containing 1 grain of powdered opium and 6 grains of acetate of lead. It is in the diarrhœa stage the pill is administered, but not later. The frequency with which it is given depends on the patient. In the collapse stage the patient is to be kept warm by hot bottles, flannels, and rubbing. In this stage the person is often recovered from apparent death by the injection into the rectum of warm water (of temperature 100° Fahrenheit), containing various salts in solution. The mixture of salts is made by taking 10 ounces common salt, 1 ounce chloride of potassium, ½ ounce of phosphate of soda, and 3 ounces carbonate of soda. Half an ounce of this, dissolved in 10 ounces of the warm water, may be injected every three or four hours. Injections into the veins of a solution of similar salts, but very much weaker, has had marvellous effects in restoring the person for the time. Light broths, cornflour, &c., form the kind of diet required. Those in attendance on the patient must take pains to keep him clean from contamination by discharges, and must use measures to destroy the chance of his discharges spreading the disease. (See Precautions during times of Cholera.)

Precautions during times of Cholera.—If cholera be threatened, everyone should see to it that preparation is made to meet the enemy. This will be effected by maintaining the strictest cleanliness in every direction. Let houses be kept thoroughly clean, so that they harbour no dirt; let drains be looked to, that any blocked may be cleared. Drains should be regularly flushed with clean water, and disinfecting material (chloride of lime, &c.) poured into them regularly, say once a week. The streets, lanes, &c., of city and village must also be kept pure, and dust and dung heaps cleaned out, and also regularly disinfected. Care must be exercised in the use of drinking-water, wells being avoided where any chance of pollution exists. Where the water supply is suspected, none should be used without being well boiled or filtered through a charcoal filter. The charcoal must be renewed occasionally or purified by strong heat. If water is boiled, the unpleasant taste may be removed by shaking it up with air in a clean vessel. Tainted meat, vegetables not perfectly fresh, over-ripe fruit, must all be carefully avoided. Milk must be carefully watched and kept in a cool place away from dust.

If cholera be in a house, the person must be removed to one room, and one person made responsible for attendance on him. All useless furniture and hangings should be removed. The room should be well ventilated, though kept free of draughts. It should also be cool. Every cloth used by him and every article of clothing should, before removal from the room, be immersed in some disinfecting solution, a solution of carbolic acid (1 ounce of acid to 20 of water), or a solution of chloride of lime. [The chloride-of-lime solution is made by putting ½ pound of the chloride into a wooden pail, stirring it, and then letting it settle. A quantity of the clear fluid is drawn off and diluted to the strength required. If it is too strong it will destroy clothes put into it.] The vessels into which vomit or other discharges are received should all contain a disinfecting material. A mixture is made by adding 1 ounce of sulphate of iron and ¼ ounce carbolic acid to 20 ounces of water. A wine-glassful of this should be kept in the vessels. After receiving the discharge, they should at once be emptied into the water-closet, the pipe should be well flushed, and a quantity of the mixture kept in the basin. The vessels, after being emptied, should be immersed in strong solution of the chloride of lime. The patient's body should be kept clean by frequent bathing with acid water (½ ounce sulphuric acid to 20 ounces of water), or with water coloured a deep pink with Condy's fluid. The attendant's hands should be frequently washed in Condy's fluid or carbolic-acid solution (1 ounce of acid to 40 of water). On the termination of the case, articles of clothing worn by the patient, the mattress on which he has lain, &c., should be destroyed by fire.

Ulceration of the Bowels.—It is useless in such a work as this to note any special features regarding ulceration of the bowels. Any mention of symptoms would be only misleading, since by unskilled persons much simpler affections might be mistaken for this disease, and much distress and anxiety thereby occasioned to the patient. But ulceration of the bowel may occur just as ulceration of the stomach, and may, in the same way, eat its way through the bowel wall and occasion adhesions between the bowel and other organs by the consequent inflammation, or may open into the abdominal cavity and set up inflammation there. (See PERITONITIS, p. 265.) Ulcerations are a chief feature in typhoid fever, the glands of Peyer (p. 199) being specially their seat. They also occur in syphilis and in tubercular disease.

Obstruction of the Bowels (*Stoppage of the Bowels*) is a very serious complaint, is indeed very fatal, and more fatal than it might be, because of the fact that it usually is some days before the true nature of the illness is recognized. Valuable time is therefore lost, and injurious treatment is very likely to have been adopted under the belief that the trouble is only extreme costiveness.

Obstruction of the bowels may be produced in various ways. It may be due to foreign bodies, fruit stones, marbles, &c., which have been swallowed. A single fruit stone is not likely to produce it; but if a number of them have been swallowed, they may become massed together to form an obstacle sufficiently large to completely block the bowel and prevent the onward movement of the contents. Moreover, if a person has been long in the habit of taking regular doses of such a powder as carbonate of magnesia, it seems quite possible for a mass of hardened material to be slowly formed of magnesia which has been taken, which in the end may be large enough to block the passage. Gall-stones which, by some means, have forced their way from the gall-bladder into the bowel, may also become obstacles.

Besides by such mechanical obstructions, the tube may be closed by accumulations of hardened fæces, or by some inflammatory process which has gradually narrowed the channel by thickening of the walls, and which, after a long period of tendency to constipation, often suddenly ends in complete obstruction.

It may be closed by tumours such as cancer. It may be closed by coiling and twisting of the gut on itself, or by the gut becoming bound down by adhesions due to inflammation, or by the bowel slipping into some narrow opening in the surrounding tissue and becoming there strangled. Rupture may become strangulated, and so produce obstruction. (See RUPTURE, p. 267.) Lastly, what is called **intussusception** may occur, in which one part of the bowel slips into another, as one part of the finger of a glove may be slipped within another part. This is commonest among children.

Symptoms.—It is usually, however, quite impossible to tell what is the cause of the obstruction. The main fact is that the person can obtain no passage. This may happen suddenly, without any previous warning, or after a long period of tendency to constipation, uneasiness, colicky pains, &c. Besides the obstinate constipation, there are sooner or later sickness and vomiting, painful colic due to peristaltic movements of the bowel (p. 239), which is endeavouring to free itself. These movements are sometimes seen through the walls of the belly. Great distension from wind adds grievously to the distress. The vomiting is at first of the contents of the stomach, and later of fæcal matter churned up by the movements of the bowel. If the small intestine is blocked, the vomiting is likely to occur sooner than if it were the large intestine in which the obstruction occurred. When the bowel is strangled, the vomiting occurs speedily; the pain suddenly comes on, the belly swells quickly, and death within a few days is apt to occur.

Treatment.—It is apparent that no time is to be lost in treating such a condition of affairs. Usually, in an ordinary form of obstruction, where the symptoms take a little time to develop, the person and his or her friends think it is mere costiveness that is the cause of all the symptoms, and purgatives are tried, dose after dose, of various kinds, each stronger than the other, till the doctor is summoned, often when the patient is already sinking. Purgatives are right enough to begin with, when the true nature of the case is not certainly known; but after it is evident that they fail to secure a passage, their continuance is a great mistake, since they cause only a greater accumulation of material above the site of the obstruction, add to the distension of the bowel above that point, and seriously aggravate the distress. On the other hand, no harm, but good, arises from large and repeated injections of warm water by the rectum. For repeated large injections will help to wash away any accumulations of fæces, and will also tend to aid in the uncoiling of any twist, while, the water having a free outlet, no danger need be feared, if the water is injected carefully and slowly. Large hot poultices should be applied to the belly, and, to relieve the pain caused by the movements of the bowel, 1-grain doses of opium (*to adults only*) should be given every three or four hours. Careful filling of the bowel with air by the use of bellows adapted for the purpose, the nozzle of which is inserted into the anus, has been successfully used for twisted bowel, and specially for intussusception. It should only be employed by skilled hands, otherwise much mischief may be done.

Such is an indication of the treatment to be adopted. Yet it cannot be too much insisted on *that these are cases to be treated by skilled men from the commencement.* Because (1) the whole cause of the obstruction may be a rupture which is not visible outwardly, and which a doctor would carefully examine for, and, if found, perhaps liberate by an operation, and because (2) where there was reason to believe that the cause of the disease was a twist of the bowel, or it being bound down by some bands of adhesion, a surgeon would probably suggest, other things failing, the desirability of opening into the cavity of the belly to discover and, if possible, uncoil or liberate the twisted or confined bowel. Such operations must, however, be done before the patient has begun to sink, in short, as early as possible. Cases are on record where a simple twist, or the binding of the bowel by a narrow band, has been the cause of the whole mischief, and where an operation has relieved and saved the patient. Patients, judging from the pain, &c., have been able to predict the exact place of the stoppage, and surgeons have also been able to do the same by external examination, or by judging of the quantity of water that could be injected by the rectum before the obstruction was reached. Valuable indications for the place of operation have thus been obtained.

Intussusception is the passage of one part of the bowel within a succeeding part of it, just as one may push half of the finger of a glove within the other half. It is also called **invagination.** The part pushed within the other is strangled, and the circulation stopped in it, so that it becomes swollen, congested, and may die. Besides, the result of the intussusception will be to block the canal of the intestine, and so produce obstruction of the bowels. It is a disease occurring most commonly among children, and therefore will be considered in the chapter devoted to DISEASES OF CHILDREN.

Foreign Bodies in the intestine have been already referred to under OBSTRUCTION OF THE BOWELS as a cause of blocking of the intestinal tube. In that article it has been mentioned that fruit stones, marbles, &c., that have been swallowed, may form masses in the bowel sufficient to block its fair way. Besides these, paper, husks of grain, pieces of egg-shell, fibres, or hairs of various kinds may become matted together with the fæces to form masses. Specially should it be noted by persons in the habit of taking large and repeated doses of powders like magnesia, chalk, phosphate of lime, &c., that these may form concretions in the bowel, which may gradually grow large enough to obstruct the bowel. Doubtless the presence of such masses will tend to irritate the bowel, and occasion irregularity of the bowels, and other disturbances, perhaps occasional diarrhœa. Besides, they may settle down in some corner or pouch, set up inflammation, and in the end cause perforation of the bowel. The symptoms that arise when they obstruct the bowel have been referred to. (See OBSTRUCTION OF THE BOWELS.)

Consumption of the Bowels (*Abdominal Phthisis, Tabes Mesenterica*).—The English word *consumption*, the Greek word *phthisis*, and the Latin word *tabes* are terms all used to imply a wasting away. When "consumption" is spoken of, it is commonly understood as applying to the lungs, and the popular phrase, "consumption of the bowels," if correct, would imply some resemblance between consumption as affecting the lungs and a disease affecting the bowels. In point of fact there is such a resemblance. Consumption as affecting the lungs may arise apparently from several causes, but one common cause is a disease called "tubercle," or "tuberculosis." The general disease to which the term "tuberculosis" is applied is briefly considered elsewhere. (See p. 551.) It is sufficient to state here that it consists in the formation of small grayish bodies, or nodules, composed of round cells, to which the name tubercles is given. The tubercles may occur in many of the organs and tissues of the body, but they are most common in the lungs and mucous membrane of the intestines. Now, the little tubercles tend to break down and to form a yellow, cheesy material, the dead and worn-out remains, as it were, of the cells that, in its early stage, formed the gray nodule. Further, the tissue immediately surrounding the nodule tends to become involved; in plainer words, the tubercle spreads, and, as it spreads round the margins, the central parts break down into the cheesy matter. It becomes evident, therefore, how a nodule, which at first was so small as to be barely visible to the naked eye, may grow to a considerable size, and evident also how its growth means the destruction of the tissue in which it happens to be. For if the central parts soften and break down, an ulcer will be formed, and with the spread of the tubercle there will be increasing size of the ulcer. Now, let this process be going on in the lungs and intestines, the chief seats of tubercle, and there is actually a consuming, a wasting-away process, going forward. This is the process that goes on in one form of consumption of the lungs, and is the process that goes on in the disease we must here briefly consider. It is worthy of remark that it is the presence of tubercles in the membranes of the brain that occasions "acute water in the head" (p. 155).

In the bowels the tubercles are found most numerously about the glands of Peyer, mentioned on page 199, and, as already indicated, by their softening they form ulcers, which have a marked tendency to spread, so that there may be large and numerous patches of ulceration in both the small and large intestines. Now, this ulceration may eat into a blood-vessel, and so cause death by loss of blood; or it may work its way quite through the bowel wall, and so open into the cavity of the belly, setting up fatal inflammation there; or, if the ulcers heal, the scars they form may so pucker the wall of the bowel as to diminish seriously the size of the tube. More than this, material from the softened tubercles, passing into the lacteal vessels (described on page 199), will reach the glands of the bowel, and will set up the diseased process there, so that glands may be converted into masses of cheesy material. Under the influence of the diseased process the glands become enlarged and hard, and in marked cases of the disease the hardened masses may be felt through the belly wall.

The disease specially affects children.

The **symptoms** may be various, dependent on the exact seat of the tubercles, whether on the outer or inner coat of the bowel. Generally they are such as these: griping pains in the bowels, irregular action of the bowels, probably looseness, which tends to grow worse, swelling of the belly, which becomes hard and tender. In advanced cases the hardened glands may be felt through the abdominal walls. There are also extreme wasting, feebleness, and thinness of body, mainly because the lacteal vessels, by means of which nourishing portions of the food are conveyed from the bowel into the blood, are affected by the disease. Recovery does sometimes take place from consumption of the bowels, but, on the whole, rarely.

Treatment is mainly directed to keeping up the strength of the patient. For this purpose, besides a nourishing, easily-digested diet, consisting of soups, beef-tea, milk and cream, eggs, &c., chemical food (syrup of the phosphates of iron), syrup of the iodide of iron, cod-liver oil, quinine-and-iron tonic, &c., are prescribed in doses proper to the age. The patient should be removed to a suitable locality, sea-air being desirable, and should be clothed with warm clothing, flannel surrounding the belly, and should sleep in a large, well-ventilated room. Pain in the belly should be relieved by hot applications. Costiveness or diarrhœa, &c., occurring in the course of the disease must be treated as such affections require. (For directions on these points refer to the paragraphs on CONSTIPATION, &c.) It must be noted that preparations of opium are largely used for the relief of pain and for diarrhœa, but that the administration of opium to children, in whom the disease is common, unless ordered specially by a medical man, who also prescribes the dose, is attended with grave risks. For that reason the main plan of treatment only is indicated here, but the multitude of accompanying complaints, incidental to the disease, cannot be properly treated by any but a qualified medical man.

Bleeding (Hæmorrhage) from the Bowels (*Melæna*).—When blood passes from the blood-vessels into the canal of the bowel, it is acted on by the digestive fluids and is made black, and frequently quite tar-like, the red colour being completely lost. From the black and tarry appearance of the motions which are subsequently passed, the term melæna is applied to the condition, from the Greek word *melas*, meaning black. If, however, the blood, which has gained entrance to the bowel, is passed too quickly for the digestive fluids to act upon it, it will retain its red colour. If, for instance, it comes from the rectum, it will be of the ordinary bright colour. The passage of blood is not to be considered a disease in itself; it is to be considered as an indication of a disease, and whether it is to be regarded as a very serious fact or one of no great consequence depends entirely on what it is supposed to signify. What it does signify may frequently be quite evident, at other times the settlement of this question may be very difficult, and demand a careful examination by a skilled person. For example, bleeding from the bowels occurring in the course of typhoid fever means the opening into a blood-vessel by the process of ulceration of the bowel. That is one of the main occurrences in this fever, and a similar thing occurs in ulceration from tubercle, cancer, &c. It may also occur because of congestion of the blood-vessels of the mucous membrane of the intestine, which may be due to inflammatory affections of the bowel, or to congestion and other conditions of the liver impeding the course of the blood, and so producing stagnation in the capillary blood-vessels of the intestines, which, as we have seen (p. 200), are the beginnings of the portal vein of the liver. It is plain how any obstruction to the passage of the blood along the portal vein will speedily act backwards on the small vessels of the intestine, and how the pressure of the dammed-up blood may cause the oozing of a considerable quantity through the walls of the distended vessels, or may even burst some of them. Constant drinking is a frequent cause of such obstructive diseases of the liver. In all of these ways blood may pass into the bowel, and be afterwards passed in the fæces.

The chief **symptom** is the passage of quantities of blood in the stools, which are in consequence usually black, like pitch. If much blood is lost, or the bleeding goes on for some time, the person will suffer in health, will be pale and weak and faint. If a large quantity be suddenly poured into the bowel, it is likely that the patient will become suddenly faint, and may become unconscious, or fall into convulsions. The cause of this may not be apparent till some time afterwards, when a large black stool is passed.

Treatment.—The various causes of bleeding from the bowels have been explained in some detail, because people are apt to think that it is sufficient to know that bleeding is occurring in order to say what remedy should be applied. Now, to take an example, it will be evident that the administration of medicines for the purpose of causing contraction of bleeding vessels, or for acting in similar ways on bleeding surfaces, will be of little use if the bleeding is from vessels distended because of some affection of the liver, some obstruction of the portal vein. Clearly, if the obstruction can be got rid of the bleeding will stop of its own accord, because the blood will get circulating, and the vessels, being no longer choked, will have no tendency to burst. Therefore, the necessity arises of determining *the cause* of the occurrence of the bleeding, a question which an unskilled person will have generally much difficulty in answering. In the end, therefore, it will be necessary for a doctor to determine what is the disease of which the bleeding is but an incident, and how it is to be treated. Till that is done, and in order to diminish the loss of blood as much as possible, the person should be kept quiet and cool, lying in bed, and should not be permitted to make any exertion. Food should be of a light sort, not warm, and given in small quantities at a time. Iced drinks in moderation may be useful, and acid drinks also. Where the bleeding was *distinctly* traceable to a loaded state of the liver, the use of purgatives to relieve the liver would be proper. The best medicines for such a purpose are a pill of ½ grain of resin of podophyllin taken at bedtime on several successive nights, or a powder of 5 grains calomel and 20 grains jalap, followed, after some hours, by a draught of some saline medicine, epsom or seidlitz salts or citrated magnesia.

Cancer of the Bowels.—Little need here be said of this affection. The part of the intestine more liable than another to it is the lower part of the rectum.

The **symptoms** are vague and unreliable. Pain, irregularity of the bowels, discharges from them, which may contain matter or blood, &c., among them. But these symptoms are associated with many other diseases of not nearly so fatal a character. Cancer may also narrow the tube of the bowel, and so obstruct the onward passage of the fæces.

The **treatment** is the same as that indicated for CANCER OF THE STOMACH (p. 236).

INTESTINAL WORMS.

There are various kinds of worms known to find a lodgment in the human body. The chief of them belong to two great classes: (1) the tape-worms or band-worms, and (2) the round or thread worms. The scientific terms for these classes are **cestodes** or **tæniæ**, and **nematodes**. Cestode is derived from a Greek word, *kestos*, meaning a band, and is therefore identical with the common word tape-worm; *tænia* is the Latin for a band or ribbon; nematode is derived from the Greek, *nema*, and means a thread. There are also found occasionally in man worms belonging to the **trematode**, or *fluke* class. *Trēma* is the Greek word for an opening, and the term was applied to the worm because it exhibits suckers which were thought to be mouths. Fluke means flat, and was used to describe the worm because of its shape.

It is the object of the following paragraphs to describe the principal examples of the above classes from which human beings suffer, along with the symptoms their presence produces, and the appropriate treatment in each case. The natural history of these animals forms a most remarkable and interesting chapter of science. On this account in the description of them some small amount of detail will be given.

Tape-worms (*cestodes, tæniæ*).—There are several species of tape-worm, namely, *Tænia solium, Tænia mediocanellata, Tænia lata* or *Bothriocephalus latus*, and *Tænia echinococcus*. The two first are the commonest.

The **Tænia solium** (*Pork Tape-worm*) is represented in Fig. 114. At *a* is the head, which is from the $\frac{1}{45}$th to the $\frac{1}{35}$th of an inch in diameter—about the size of a small pin head. From the head there passes a slender neck, with cross strips, which gradually becomes broader and flatter till the body is reached. The latter part of the animal consists of a series of segments or joints (*b, b*), which are shown in the figure about the natural size. The complete tape-worm measures 7 to 8 feet in length, and towards the lower end the joints measure about $\frac{1}{4}$ of an inch broad and $\frac{1}{2}$ inch long. There may be as many as 1200 joints in one tape-worm. Now it must not be understood that this great length forms one individual; it consists, properly speaking, of a colony of individuals. Each fully-developed joint is perfect in itself, and independent, having within it the capacity for reproducing its species, and being entitled to be regarded as a distinct animal. To each joint the term *proglottis* is applied. To the long colony of proglottides which, dependent from the head, go to form the tape-worm, the term *strobilus* is applied. The head is called the *scolex*, and is to be considered as the parent of the whole colony, as will be understood immediately. It is by the scolex or head that the tape-worm is anchored to the mucous membrane of the intestine in which it dwells. A head is represented magnified in Fig. 115, 1. It has a projection or proboscis (*a*) at the extremity, which is surrounded by a double row of hooklets (*b*), there being twelve to fourteen hooklets in each row.

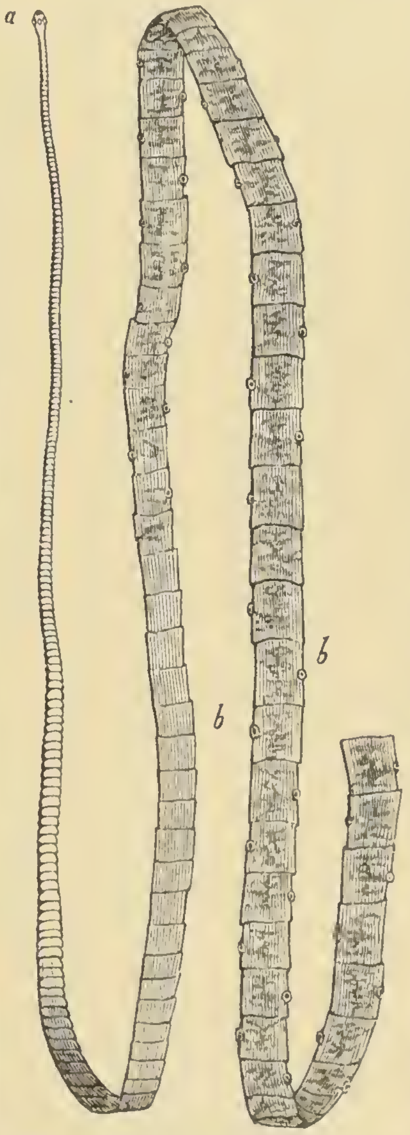


Fig. 114.—Tænia Solium (Pork Tape-worm).

The shape of a hooklet is represented in Fig. 115, *d*. A little above the middle of the head are four projecting suckers, three of which, *c,c,c*, are represented in the figure, by which it is aided in maintaining its hold in the intestine.

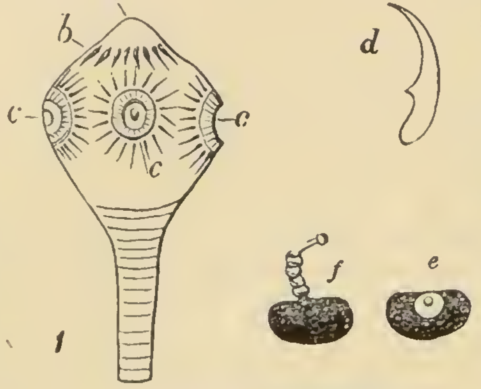


Fig. 115.—Parts of the Pork Tape-worm.

Now let us trace the history of this parasite.

It may remain in the bowel of the individual whom it infests, and who is called its *host* or *bearer*, for many years, deriving its nourishment, not by a mouth, for it has none, but by the passage through its soft body wall of some of the nourishing fluids by which it is bathed. During its lifetime it goes on shedding fully-developed joints from its extremity, while its length is maintained by the continual formation of new joints between the head and those already formed. As new joints are produced, those already formed are pushed farther and farther from the head, becoming developed as they pass from the head, till in their turn they are separated from the rest of the strobilus and are passed by the person. The passage of the joints is a circumstance of great discomfort. A ripe joint, or proglottis, is filled with eggs, the seed capable of producing a multitude of other tape-worms, provided suitable soil is found for them. The eggs are contained in a branched structure in the joint, indicated in Fig. 114, and one joint, it has been estimated, may contain 45,000 eggs. When a joint is passed it is still able to elongate and contract, and at length is ruptured, by means of which the eggs are liberated and scattered abroad. Each perfect egg contains a tape-worm, but in its embryonic or larval stage, in which it has little resemblance to the fully-developed worm. The embryo is only about the $\frac{1}{1250}$ of an inch in breadth, and is inclosed within a thick brownish shell, which protects it from destructive agents, the shell resisting even ordinary chemical agents. The head of the minute embryo carries three pairs of hooklets instead of the crown of hooklets of the scolex, and they are formed, not for holding on, but for boring and tearing. The eggs, then, containing such embryos are dispersed abroad. They get into sewers, into water, and in one way or another are scattered also over fields. They are liable to be swallowed by man or by animals in drinking-water, and to be swallowed by animals while grazing. But man and animals in general are not suitable soil for them. This is fortunate, else how few would escape becoming a home for them. There is one animal which, *in this stage*, is suited as soil for their development, and that animal is the pig. Let a pig in its eating or drinking swallow some tape-worm eggs. In the pig's stomach the egg is dissolved and the little embryo is liberated from its case. It does not remain in the stomach, but forthwith proceeds, by means of its boring apparatus, to pierce its way through the walls of the stomach and other tissues, till it reaches a place convenient for its settling down. It may get into a blood-vessel and be thus carried to some suitable organ, liver, brain, &c., but it specially selects muscle, and, in particular, connective tissue between muscular fibres. Having reached a proper place it loses its boring apparatus and gains the circles of hooklets characteristic of the head of the perfect tape-worm, and it develops at the extremity opposite the head a small sac or bladder filled with fluid. In the living state the head and neck are coiled up in the sac (Fig. 115, *e*), but they project from the sac after death (Fig. 115, *f*). It is now called a **cysticercus cellulosæ**, and it has now completed its second stage, being incapable of further growth within the body of the pig. In the pig, that is to say, it remains a bladder-worm and will not produce the perfect tape-worm. In the flesh of the pig it appears as a little round or oval sac, the size of a pea or even larger (Fig. 115, *e*).

Now a pig may have swallowed only a few eggs or a multitude. If the latter has been the case there will be a multitude of such cysticerci in its flesh, and the pork will have what is called a "measly" appearance. "Measles" of pork are due to these cysticerci or immature tape-worms. Now, before the cystic worm can produce a tape-worm it must be transferred to the body of some other warm-blooded animal. Suppose a man eats a piece of "measled" pork *which has not been cooked well enough to destroy the vitality of the cysticercus*, after the piece of meat reaches the stomach the embryo is freed from its cyst by the action of the gastric juice. It thereupon attaches itself by its circle of hooklets to the mucous lining of the bowel, the tail vesicle drops off, and it becomes a scolex. Immediately behind the head minute segments are produced by a process of budding, and, in from twelve to sixteen weeks, some segments may have become quite mature and be passed as joints by the patient, at which time the tape-worm has reached its adult form.

There are thus three main stages in the development of the tape-worm:

I. The egg stage in the fully-developed joint or proglottis.

II. The stage of cysticercus, developed from the egg in the body of a pig; and

III. The tape-worm stage, produced in man by the eating of pork containing the parasite in its second stage. The joints of the fully-developed animal produce the eggs, which must escape from the body of man and gain entrance to the body of a pig to undergo development.

We have seen that it is in the pig particularly that the eggs of the tape-worm attain the second stage of their growth, and that it is specially from eating improperly cooked "measly" pork that persons are liable to get tape-worm. Yet the cysticercus stage may be developed in other animals, and it has been found, though rarely, in the muscles, brain, and eye of man. It is, nevertheless, the development in the pig that is common and worthy of remembrance. For this reason this form of tape-worm has been called the "pork tape-worm."

The symptoms and treatment, and what in some respects is of even greater importance, the prevention of an attack of tape-worm, will be considered when the other forms of the parasite have been described.

Tænia mediocanellata (*Beef Tape-worm*).—This tape-worm goes through a series of wanderings and transformations precisely similar to those of *Tænia solium.* It is, however, no longer the pig but the ox or the calf that affords the most suitable soil for the development of its embryo form. Lodged in the intestinal canal of man, it gives off joints just as the former tape-worm. The joints contain eggs, which are dispersed and find their way ultimately into the stomachs of cattle, whence they work their way, by means of a boring apparatus, into the tissues of the animal and give rise to the "beef measle." This form has, therefore, been called the beef tape-worm. If a piece of improperly cooked beef containing "measles" be eaten by a person, the embryos become free, settle in the bowel, and develop into the *Tænia mediocanellata.* But while the natural history of the parasite is similar to that of the pork tape-worm, beef or veal being substituted for pork, in its structure it differs to a considerable extent from *Tænia solium.* Viewed by the naked eye the two could not readily be distinguished. The beef tape-worm is, nevertheless, longer, being from 15 to 23, and even 30 feet long, and its joints, or proglottides are broader. The head also differs from that of *Tænia solium* in that it has no proboscis nor circle of hooklets. It has, however, four sucking discs as shown in Fig. 116, which represents the head. The absence of the hooklets is of considerable significance. We have seen that the circle of hooklets of the pork tape-worm affords a means for securely anchoring the head to the mucous membrane of the intestine. So firm is this anchorage that it constitutes one of the difficulties of treating the pork tape-worm, the medicines administered often failing to detach the head, and so long as the head remains there is a risk of the tænia going on developing fresh joints. The beef tape-worm, having no hooklets, is less securely fastened and more easily brought away. It is commoner, therefore, to get a specimen of a *Tænia mediocanellata*, complete with head, than to get a complete *Tænia solium*, the head, in the latter case, being frequently wanting. Owing to this difference the pork-worm is often called the "armed tape-worm," and the beef-worm the "unarmed tape-worm." It was formerly supposed that the pork tape-worm was the commonest of all tape-worms, but Dr. Spencer Cobbold declares that the facts warrant him "in styling this worm [the *beef* tape-worm] the most common of all tænia liable to invade the human body." He also goes on to say "it seems strange to speak of measly beef, and yet, probably more diseased beef exists in this country than similarly-affected pork."

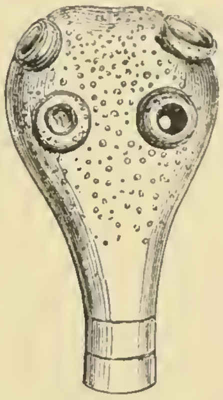


Fig. 116.—Head of Beef Tape-worm (highly magnified).

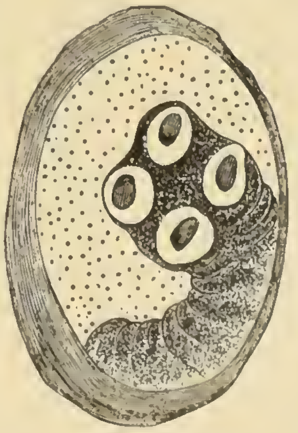


Fig. 117.—Beef Measle (Cobbold).

The beef measle, the cysticercus stage, that is, of the *Tænia mediocanellata*, is smaller than the pork measle—not so large as a pea—and is much more easily overlooked. The head of the embryo worm within its cyst is, however, a little larger than that of the pork-worm, but, like the head of the fully-developed parasite, it has no hooklets. A magnified view of one of the cysticerci of the ox is given in Fig. 117. It has never yet been found in man.

The beef tape-worm has been found very prevalent in the cattle of the North-west Provinces of India. This was traced in one case to the bad drinking-water supplied to the cattle, sewage, containing the seeds of the tape-worm, being found in the tank from which many of the cattle were watered. The cattle belonged to the army commissariat, and if a barrack cook did not thoroughly cook the meat, tape-worm might have been given to many of the soldiers.

Bothriocephalus latus (*Broad Tape-worm*).—This variety of tape-worm is not common in Britain. It has been called the Irish Tape-worm, though it is commonest in the cantons of West Switzerland and their neighbourhood. It is common also in Russia, Sweden, and Poland. It was at one time very common in Geneva, but seems now comparatively rare there. This change is said by Van Beneden to be due to the fact that whereas, formerly, the water-closets were made to empty themselves into the lake, where the embryos were hatched, and so infested persons who drank of the water, now the refuse of the towns along the lake is collected for manuring the land.

The fully-developed tape-worm is of great length, more than 25 feet, and is estimated to possess as many as nearly 4000 joints. The joints, however, are not so long as those of the kinds already considered, but are much broader, and they do not separate from one another so readily as those of *Tænia solium* or *mediocanellata*. The head is club-shaped, without suckers or hooklets, but having a long slit-like groove on each side. A highly-magnified view of one side of the head is given in Fig. 118. The features of this tape-worm are, then, its great length, its very numerous, short, but broad joints which are closely packed, and its club-shaped head. Each egg is inclosed in a brownish shell, and the presence of the eggs gives to each segment a brownish-yellow colour, specially towards the *centre* of the segment, where is the aperture from which they escape. In *Tænia solium* it is to be noted this aperture is at the *side* of the segment.

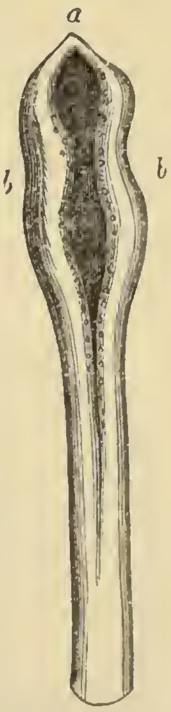


Fig. 118.—Head of the Broad Tape-worm.

The natural history of the broad tape-worm is not so thoroughly known as that of the varieties already described. It seems, however, to pass through stages precisely similar to other tape-worms. That is to say, the fully-developed head, or *scolex*, throws off joints (*proglottides*) containing eggs. The eggs produce embryos which develop into the embryos with boring apparatus for tearing their way into the tissues of an appropriate host. The flesh of this host, improperly cooked and eaten, will give rise to the fully-developed tape-worm in the alimentary canal of the person who has eaten it. The embryo liberated from the egg is ciliated, that is, covered with long fine hairs. From the ciliated embryo the boring embryo is produced. In what animals these intermediary stages are realized is not known with certainty. Cobbold believes it is certain fresh-water fish, of the salmon and trout family, as suggested by a German observer, in which the embryos are developed. According to Van Beneden, however, the tape-worm passes from man to water "under the form of an egg, or of a proglottis, and from the water to man in the shape of a ciliated embryo. In this manner it is introduced with the water that is drunk."

There is still a fourth variety of tape-worm, that must be described, which is found in man, not, however, in the adult condition, but in one of the preliminary stages, the *Tænia echinococcus*, namely. It differs in so many respects from those already described that it will be better to discuss the symptoms and treatment of the latter before going on to consider it. Those that have been considered are the chief tape-worms found in the adult condition in man. There are many other varieties of tape-worm, however. Thus in the flesh of the rabbit is the cysticercus stage of a worm that attains its complete development in the dog. In the brain of sheep, infected with the disease called "gid", is an immature condition (the cause of the disease) of the tænia of the wolf. The tænia that infests the cat has previously lodged in the mouse or rat. Almost all birds nourish large tæniæ. "Woodcocks and snipe always have their intestines stuffed full of tænia and the eggs of these worms. Every bird contains them by thousands. Fortunately we cannot be infested with the tænia of the snipe and the woodcock."

The symptoms of tape-worm.—The usual symptoms that give rise to a suspicion of the presence of worms in the intestinal canal are colicky pains and irregularity of the bowels, picking of the nose, grinding of the teeth during sleep, bad or capricious and sometimes voracious appetite, increasing thinness of body, foulness of breath, itching of rectum and fundament, sickness, dizziness, headache, nervous irritability, and a tendency to faintness, &c. Yet worms may be present without any of these signs manifesting themselves. On the other hand, the presence of worms may give rise to other symptoms of a very serious kind which yet do not in any way indicate their cause. For example, the irritation of worms may produce convulsions or attacks of St. Vitus' dance, specially in children, and may occasion hysterical attacks in women. Cases are on record of tape-worm producing insanity, epilepsy, paralysis, blindness, and squint.

There are no special symptoms associated with the presence of the cysticercus stage in the human body.

In all cases the only conclusive sign of worms is the passage of a worm, or parts of one, in the fæces, which ought in all suspected cases to be carefully scrutinized.

The **treatment of tape-worm** is happily not difficult, is perfectly safe, and usually successful. The drug now most esteemed is the male-fern root, of which both powder and extract may be used, but the extract is preferred. Half a tea-spoonful to one tea-spoonful and a half (according to age) of the liquid extract should be given, made up with a little syrup of ginger and water. It acts best when taken early in the morning, only liquid nourishment having been taken the previous day. This secures that the tape-worm is not protected from the drug by masses of food-stuffs. Four hours after the medicine a strong dose of castor-oil will aid in bringing away the worm. The powders of kousso and kamala are also admirable for destroying tape-worms. Of either of them 60 to 180 grains are given, made up with honey or syrup, early in the morning, and are followed, after some hours, by a purgative dose of castor-oil. In the absence of any of these medicines oil of turpentine may be employed, 1 to 3 tea-spoonfuls being given with 4 tea-spoonfuls of castor-oil, also early in the morning.

The stools that are passed after the administration of the medicine ought to be carefully scrutinized, not only for joints of the tape-worm, but for its whole length, and specially for its minute head. As has been already mentioned, the *Tænia solium* is firmly secured to the mucous membrane of the bowel by its crown of hooklets. It is more difficult, consequently, to remove it than the head of other kinds. Since it is from the head that the production of joints occurs by budding, one's security is greatest if the head has been detached and voided in the stools.

Tænia echinococcus (*Hydatid*) is a form of tape-worm whose adult condition is found in the dog and wolf, but which may exist in the human body in a larval or immature condition, in which state it forms cysts or sacs, filled with fluid (hydatid cysts), and of various sizes in various organs of the body, but specially in the liver. "Where dogs are not kept it is well-nigh impossible that the disease should be contracted." The disease is very common in Iceland, where, at one time, it was estimated there were as many as 10,000 people suffering from it. "The fact that every Icelandic peasant possesses on an average six dogs, and that these dogs share the same dwelling (eating off the same plates and enjoying many other privileges of intimate relationship) sufficiently explains the frequency of hydatids in that country." In Britain dogs are comparatively rarely infested with this tape-worm. In Australia the hydatid disease is also very common, being very prevalent in Victoria. A magnified view of the fully-developed tænia, as found in the dog or wolf, is shown in Fig. 119. It is very much smaller than the other tæniæ that have been described, measuring only $\frac{1}{4}$th of an inch in length. It contains only four segments. One segment forms the head, which has a pointed extremity, a double crown of hooklets, numbering thirty to forty, and four suckers. The last segment is as long as the other three put together, and contains the eggs. The eggs, set free from a dog, may gain access to water, and thus, in drink or in other ways, may be introduced into the body. The eggs are acted on in the stomach, and from them are liberated embryos with six boring hooks, which work their way into the blood-vessels of the person, and are thus distributed throughout the body. Having arrived in a suitable organ, the embryo undergoes changes by which it becomes converted into the hydatid cyst, in which form it is found in man. The cyst is a sac of varying size, at first small, the size of a nut or less, but capable of growing to a size equal to that of a child's

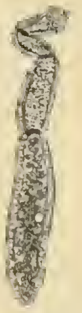


Fig. 119.—Tænia echinococcus (Cobbold).

head. The cyst is filled with granular and fluid contents. From the walls of this sac others grow bud-like. These are called "brood capsules," because it is within them that the second stage of the *Tænia echinococcus* is developed. The contents of a brood capsule become converted into an echinococcus head, which is about the $\frac{1}{120}$th to $\frac{1}{200}$th of an inch in length and of an egg shape. The head has a proboscis with a double circle of hooklets, and there is a constriction in the middle of the small structure which divides the extremity with the head from the other. Fig. 120 shows a cyst with brood capsules in its interior, and above this figure is represented one of the echinococcus heads as removed from its capsule.

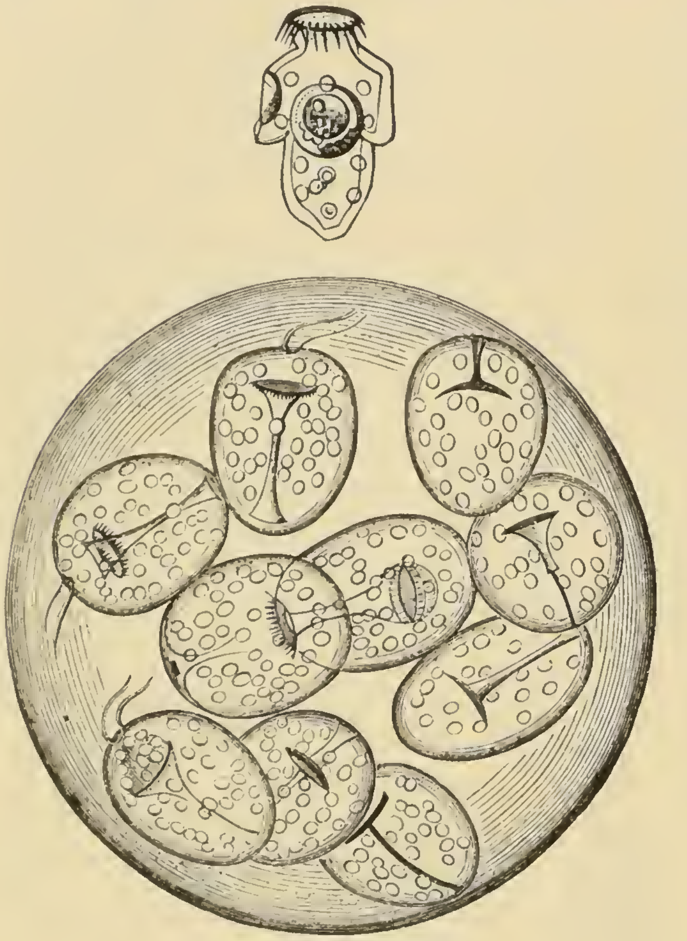


Fig. 120.—Hydatid Cyst.

Symptoms.—It is scarcely necessary to enter into the question of the symptoms of hydatid cyst. It usually affects the liver, and manifests itself as a swelling which gradually enlarges so as to cause a projection of some part of the belly. It may occasion symptoms of dyspepsia, or, by pressing on and obstructing the bile-ducts, produce jaundice, or by pressing on blood-vessels cause dropsy, piles, &c.

Treatment.—No medicine can destroy the hydatid nor arrest its growth. What can be done is to puncture the tumour and draw off the fluid by means of a fine tube. This, of course, is a question and procedure for a surgeon. If an examination of the fluid by the microscope shows the presence of hooklets (as shown in Fig. 115, *d*, p. 258), which have been detached from the echinococcus heads, the nature of the tumour is evident.

The Prevention of Tape-worm.—The prevention of hydatid may be disposed of first. It has been noted that the seeds of the parasite are obtained from the dog, and that where dogs are not kept "it is well-nigh impossible that the disease should be contracted." Where dogs are kept, care and cleanliness should remove all risk of disease. A dog affected with tape-worm should receive physic at intervals. Dr. Cobbold advises that its excreta should be burned, and that boiling-hot water should occasionally be thrown over the floors of all kennels where dogs are kept. The eggs are destroyed by the heat of boiling water. If there is any risk of them getting into drinking water, it should be boiled before use. To improve its taste afterwards it should be shaken up with air. Careful filtering through a charcoal filter will keep back the seeds. The filter should not be used too long without heating, to destroy ova that have been retained by it.

The prevention of other forms of tape-worm may also be secured by care and cleanliness. As we have seen, the common tape-worms are derived from measled beef or pork, and if one eats no measled beef or pork no danger is incurred. But one cannot always be sure that no measles exist in the meat one is eating, and it is of the utmost consequence to know whether there is any method of securing that any bladder or cyst worm that meat may contain is destroyed before it is eaten, so that it becomes unable to produce the mature tape-worm. There is such a method, and it is by heat. The cysticercus of the beef or pork tape-worm cannot survive a temperature of 140° Fahr. continued for five minutes. That temperature is considerably below the boiling-point (212° Fahr.). This has been made quite certain by the experiments of an Italian, Dr. Perroncito, who submitted the cysts to various temperatures, and who found them die when they were heated up to 120° or 130° Fahr. His results were proved by some students, who, of their own free-will, swallowed some so heated, but were never affected with tape-worm.

A sufficient degree of heat, then, kills the measles of veal, beef, or pork. It is, therefore, certain that meat properly and thoroughly cooked cannot occasion tape-worm. It must be noticed that to destroy measles in meat the meat must be heated through and through to the proper temperature. The outside of the meat might be heated sufficiently, but the inside not nearly enough, so that measles in the deep parts would escape. This ought, therefore, to be watched in the cooking of any large piece of meat. Minced meat and sausages ought to receive special attention.

Another danger must be avoided. A cook who has cut up meat containing measles may harbour them on her hands. She may cook the meat properly enough, but in serving it up, if she has not previously washed her hands, may introduce the parasite on to the plates; or if a cook uses the knife, with which the uncooked meat has been cut up, to serve the food up for dinner, without cleaning it properly, the cystic worm may be conveyed to the cooked food.

It seems that measles in cattle have no very long term of existence. Dr. Cobbold has shown that an animal with measles is cured naturally, by the death of the parasites, after the lapse of ten months. Beyond that term the cysticerci do not live; they die and are subject to chalk-like degeneration. Cattle known to be measled should, therefore, be sent to some place where there is no chance of them getting a fresh infection, and should be kept there for eight to ten months. At the end of that time, if they have not meanwhile received a fresh supply, it would not be possible for their flesh to produce tape-worm, even though it were undercooked before being eaten.

Thus cleanliness in every respect, and thorough cooking of all meat, are effectual preventives of the occurrence of tape-worm.

II. **Round-worms** (*Nematodes*) are different in appearance from tape-worms. They are not flat like the latter, but present characters resembling earth-worms, having elongated round bodies marked with cross ridges. They have a mouth at one end, an anus near the other extremity, and an alimentary canal connecting the two. They offer this great distinction to the tape-worms, that the sexes are separate, the male being smaller than the female. Their natural history is not so well known as that of the tape-worms. It seems certain, however, that they have several stages of existence like the tape-worms, and that these different stages are passed in different "hosts" or "carriers." It seems evident that they cannot grow and multiply in the intestinal canal of man. The seeds which a female will discharge in a day number many thousands, and, if it were possible for their eggs to be hatched in the intestinal canal of man, the number of worms of which he might be the victim would be beyond estimating, and would produce symptoms such as are never experienced. It appears, therefore, that the ova or seed must be expelled from man's intestinal canal, must develop in some other place or animal, and must return to man in a more advanced stage in drinking-water, along with food or flesh, or in some other way, before the mature animal can be produced. Where these secondary stages are produced is not known.

The Common Round-worm (*Ascaris lumbricoides*) is shown in Fig. 121, and resembles in appearance the common earth-worm. The females measure from 10 to 14 inches in length, and from $\frac{1}{4}$ to $\frac{1}{3}$ inch in thickness, while the males are 4 to 6 inches long and correspondingly narrower. The female produces eggs about the $\frac{1}{340}$ to $\frac{1}{440}$ inch in size to the number of 160,000 daily. The eggs are contained within a shell and pass out in the fæces. It would seem that the round-worm of man and that which infests the hog are the same, and that perhaps the hog is the animal in which some stage of the parasite is accomplished.

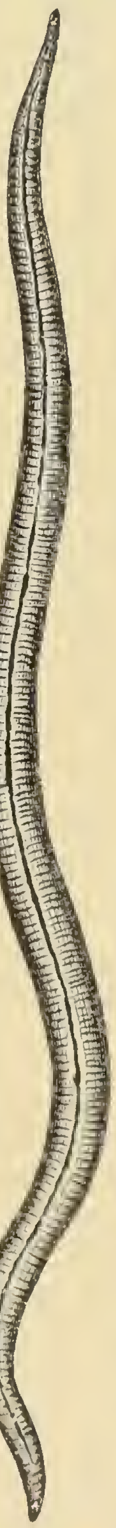


Fig. 121.—The Common Round-worm.

Impure drinking-water may be a source of infection.

Usually only six or eight of the worms inhabit the intestinal canal, though cases are on record of one person harbouring a multitude.

It is the upper and middle part of the small intestine that the worm frequents, though it may wander upwards or downwards.

Symptoms.—Persons may harbour worms and yet manifest no indications of their presence. But symptoms of intestinal irritation may arise, such as colicky pains, sickness and vomiting, looseness of bowels, itching of the nose and anus. Convulsions in children are not infrequently caused by the irritation of worms. Epilepsy has been produced by them, and various other nervous diseases.

Treatment.—Santonin, the active principle of santonica, is the best remedy. It is given in doses of from 1 to 3 grains for a child, and twice as much for an adult. It should be given in the morning in cream, and followed an hour or two afterwards by a dose of castor-oil.

Common Thread-worm (*Oxyuris vermicularis, Seat-worm*).—This is specially the worm which plagues children. It is shown in Fig. 122, the female (*a*) and male (*b*) magnified considerably. The female is from $\frac{1}{3}$ to $\frac{1}{2}$ inch long, and the male about half that size. They occur in the large intestine, specially low down. They are often present in very large numbers, and may be passed in ball-like masses coiled up with one another. In females they may pass out of the anus and into the vagina, setting up irritation there, inducing itching, excitement, and discharge.

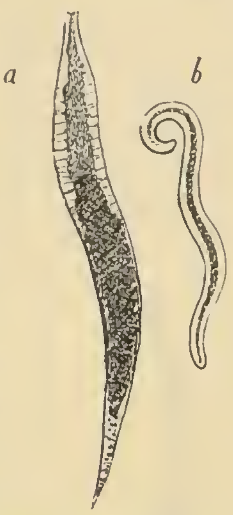


Fig. 122.—The Common Thread-worm.

It appears that this worm may pass through its various changes of development in the same host. But the eggs, it seems, cannot be hatched in the lower bowel. A person, however, troubled with these worms may infect himself by the accidental conveyance of the eggs from the anus to the mouth. By scratching, the person may catch up eggs under the finger nails, the eggs pass into the stomach, and the action of the gastric juice enables the hatching to take place.

The **symptoms** are those of irritation, itching of the anus and nose, restlessness, and nervousness. They are worse at night. Children grind their teeth, toss off the clothes, &c., and, as with the round-worms, may be attacked with convulsions. The appetite is often excessive and the bowels irregular.

Treatment.—Santonin, 1 to 3 grains, along with $\frac{1}{4}$ grain of podophyllin, is given to drive the worms down as far as possible. After that, repeated injections of warm water to which salt is added bring them away. Injections of water with infusion of quassia may also be used. The patient should also get good food, vegetables being avoided, and should have a course of quinine and iron tonic.

The Whip-worm (*Trichocephalus Dispar*) is more common on the Continent than in Great Britain. It abounds in Italy, Egypt, and the United States of America.

The female is about 2 inches long, and the male $1\frac{1}{2}$ inch. The worm has a thick rounded body ending in a fine thread-like tail, which is about two-thirds of the entire length of the animal.

Symptoms of its presence seem to be absent as a rule. Its presence may be discovered by the detection by the microscope of the eggs.

Treatment is the same as for the round-worm.

Dochmius duodenalis (*Sclerostoma duodenale*) is the name of a worm common in Egypt and Northern Italy. It measures nearly $\frac{1}{2}$ inch long. They attach themselves to the lining membrane of the upper part of the small intestine, and suck the blood of their victims. They thus produce bloodlessness in the person, and occasion the disease called chlorosis, or green-sickness, caused by loss of blood. They may kill in this way. They were the cause of a serious fatality among the labourers at work on the St. Gothard Tunnel.

The treatment consists in giving extract of male-fern, as advised for tape-worm (p. 261).

Trichina spiralis (*The Flesh-worm or Spiral Thread-worm, Trichinosis*).—This is a worm to which man and flesh-eating animals are liable. It is shown in Fig. 123, highly magnified, where it is seen to be coiled up in a lemon-shaped cyst. The worm is very small, the male measuring $\frac{1}{18}$ inch, and the female $\frac{1}{8}$ inch. They inhabit the voluntary muscles of the body, and to the naked eye appear in their cysts as minute white specks. The specks are gritty, because of particles of lime that get deposited in the walls of the cyst. The history of the parasite is as follows:—Man is infected with them from eating the flesh of some animal containing them. The pig especially is the source of infection, but they are capable of living in other animals—cats, dogs, rabbits, calves, &c. A person having eaten improperly cooked meat containing the Trichinæ, the capsules are dissolved by the gastric juice, and the worm freed. It develops rapidly, becomes mature on the second day, produces eggs which, while still within the womb of the mother, develop embryos. The embryos escape into the intestinal canal of the host after the sixth day and proceed to wander. They eat their way through the intestinal walls and migrate through the body. Gaining entrance to blood-vessels, they are carried to every organ. They seek the muscles, into which they

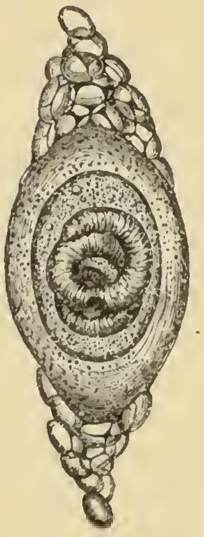


Fig. 123.—Trichina spiralis.

pass and settle down among the connective tissues between the fibres. They have reached their destination in about fourteen days. In its place the worm becomes coiled up, and in time a cyst is formed round it. One pig infected with Trichinæ may contain as many as sixteen millions, and yet may never display any symptoms of irritation. In man, however, serious symptoms arise, and death often results.

Symptoms.—Within a day or two after eating the infected meat, the person suffers from thirst, loss of appetite, irregularity of bowels, perhaps diarrhœa, pains and uneasiness in the belly; in short, there are signs of intestinal irritation. There are also some fever and quickened pulse. Later, when the person may be recovering from these symptoms, and at the time when the young animals pursue their wanderings, there are rheumatic-like pains in the limbs, only it is the muscles, not the joints, that are affected, and the pain is accompanied by swelling. The limbs become stiff and cramped, and dropsy of the face appears and soon becomes general. The fever increases, and may become excessive. Death may result early from inflammation of the bowel or of the abdominal cavity, or may occur later from exhaustion. The disease lasts from a month to three or four months.

Treatment.—No treatment will destroy the worms after their wanderings have begun. All that can be done then is to support the patient's strength. If a person suspects he has swallowed diseased pork, he may ward off the attack by the use of purgatives and the use of such remedies as have been recommended for tapeworm. This must be done early, before the young can be hatched.

But of great consequence is the fact that the disease due to Trichina, called trichinosis, may be prevented by care in the use of pork, sausages, ham, &c., and by thorough cooking of such flesh. Trichinosis is very common in Germany, attributable to the fact that the people eat a great deal of only half-cooked, and indeed nearly raw, ham.

DISEASES OF THE ABDOMINAL CAVITY AND WALLS.

Peritonitis.—There has been mentioned on p. 189 the delicate membrane which lines the wall of the belly within, and clothes the intestines. It is called the peritoneum, and it is subject to inflammation, which is called peritonitis.

It is caused by injury. A severe blow on the belly is liable to produce it, and it is often set up by a wound piercing the belly. Cold seems also to produce it. Often it is the result of ulcerations of the stomach and bowels (see p. 253), which eat their way through the intestinal walls, and permit the escape of material into the cavity of the belly, which irritates the membrane and excites the inflammation. It results often from various diseases of liver, kidneys, &c. A grave form occurs in women after child-birth, due, apparently, to the absorption of poisonous discharges from the womb. [Refer to Diseases of Women—Puerperal Fever.] Matter may form in the course of the disease, and an abscess be formed within the belly.

The **symptoms** are chiefly pain and fever. The pain is severe, cutting, or burning, and at first usually limited to one place, but it extends. It is increased by pressure, and is thus distinguished from the pain of colic. So severe is the pain that the patient lies on his back, the muscles of his belly on guard to prevent anything coming in contact with it, his knees drawn up to relax the parts. Even the weight of the bed-clothes can hardly be borne. The fever is considerable, pulse frequent and sharp, skin hot and dry, tongue coated, and there is usually costiveness. If the urine cannot be passed, it indicates the inflammation is low down. The disease is often fatal; and the case is very serious if the belly becomes swollen up, if the extremities become cold, the face pale, pinched, and anxious, and the pulse thready and weak. If the inflammation is the result of perforation of the bowel, the pain is sudden and severe, there are cold sweats, faintness, and vomiting, followed by the signs of fever and inflammation, if death do not speedily result. In milder cases there is fever, pain in the belly at one place, increased on pressure, costiveness, furred tongue, &c.

The disease should not be prolonged beyond a week unless it becomes chronic. In chronic cases the symptoms are vague, and include pain in the belly, not very marked and often colicky, tenderness of belly and swelling, weakness and paleness. The swelling is often due to accumulations of fluid—the result of the chronic inflammation.

Treatment.—The patient should be kept perfectly quiet in bed, and hot cloths should be kept constantly applied to the painful region of the belly. The pain must be kept down by opium, of which (to an adult) 1 grain may be given at a time, or 30 drops of laudanum may be given instead. It is to be repeated as seems desirable, the purpose being to keep the pain down, but not to throw the patient into stupor. Vomiting gives rise to great pain, and must be avoided by giving the patient small pieces of ice to suck, and by warm applications over the stomach. Fluid food is to be given—beef-tea, thin soup, milk, &c. The question of relieving the bowels is often a difficult one, because it would greatly increase the risk of perforation, if such were present. It is a question for a medical man to decide, and in any case a warm-water injection is safest. Often the urine must be drawn off by a catheter. (See APPLIANCES FOR THE SICK-ROOM.) If the patient become weak and collapsed, stimulants are needed.

An abscess that has formed may open into the bowels, and the matter may come away with the fæces. It would be much more desirable that a doctor should discover the presence of the abscess and draw off the matter.

For chronic cases nourishing diet is required, sea-air, friction of the belly with cod-liver oil, iodine liniment, &c.

Dropsy of the Belly (*Ascites*) is an affection that may occur as a complication in various diseases. It may be due, as we have seen, to the accumulation of fluid poured out from the blood-vessels as a result of chronic inflammation (peritonitis). In many cases it is the direct result of too full blood-vessels of the abdomen. Anything which impedes the due return of blood from the veins of the abdominal organs through the liver to the heart is apt to produce it, because, the veins and small vessels being gorged with blood, watery portions of the blood filter through the delicate walls of the vessels to relieve the pressure, and thus the fluid accumulates. Its amount will thus depend, among other things, on the fulness of the vessels and the length of time the obstacle to the free circulation has occurred, and may vary from a few pints to some gallons. Now this obstacle may exist in the liver, may be due to simple congestion of the liver, but more commonly to that thickening of the liver called cirrhosis (see p. 272), which is a frequent result of constant drinking. Of course it might be caused by some tumour pressing on the great veins, and thus blocking the return of blood. Disease of the heart or of the lungs, by impeding the due circulation of the blood, may occasion it, because the blood is penned up in the veins, not being able to get along quickly enough.

Symptoms.—The belly is large, swollen, and bulging out at the sides, the blue veins showing on the surface. The question whether the swelling is caused by fluid is settled by "percussion." Percussion is practised by laying a finger of one hand flat on the belly and tapping it sharply with the point of a finger of the other hand. If this be done over the healthy belly a clear sound is heard, like that given out by tapping a hollow vessel filled with air. Now, if the patient lies on his back, the fluid will seek the lowest level, and on tapping on the middle of the belly, which is uppermost, the clear sound will be given out, but on tapping low down at the sides the sound will be dull, like that produced by tapping a solid block of wood. In this way, by tapping all over the belly, the extent of the accumulation of fluid is determined. A solid tumour, however, would give forth as dull a sound as a collection of fluid. The determination of the presence of fluid is made by laying the one hand on one side of the belly and giving a sudden tap with the fingers on the other side. If there is fluid present, a wave is sent through it, and a thrill is communicated to the hand resting on the belly. In women there is a dropsy of the ovaries (see DISEASES OF WOMEN), which requires skill to distinguish from dropsy of the cavity of the belly. The legs and genital organs tend to become dropsical from the pressure of the fluid in the belly on the veins there. Breathlessness is occasioned from the mere mechanical difficulty offered by the swelling, and the breathlessness is worse on lying down. Severe diarrhœa sometimes occurs.

The **treatment** depends on the cause of the dropsy. It consists usually in the administration of medicines to cause sweating, a copious flow of urine, or a copious watery discharge from the bowels. On the whole, the two former are not risky, like the latter, for the administration of strong purgatives may seriously weaken the patient when he needs strengthening. There can be no harm in administering spirit of nitrous ether or squill to encourage the flow of urine. Quinine and iron tonics often help by strengthening the patient. The disease, however, should be left to the treatment of a physician. Tapping, that is, passing a fine tube through the walls of the belly to permit the fluid to escape, is practised when the swelling is great.

Other forms of dropsy are referred to on p. 339.

Tumours of the belly may be of a great variety of kinds. They may be connected with the liver, with the kidneys, with the spleen, with the glands of the bowel, and with the bladder: they may be formed by accumulations of matter after peritonitis; in women they may be connected with the womb or ovaries. It is useless to say anything of them here. They offer great difficulties often to skilled men in endeavouring to discover their nature, and the proper treatment for them.

Rupture (*Hernia*) is that condition in which there is a projection of part of the bowel or mesentery (p. 190) through some unusual opening in the wall of the belly, the projection appearing as a tumour or swelling on the outside. In males the tumour usually appears in the groin, and may pass down into the testicle. It is common here, because about the centre of the groin the spermatic cord passes out of the belly and down a canal to the testicle. Usually the rupture forces its way along this canal under cover of the skin, fat, and tendinous layers. In women it may occur in a similar region, or towards the centre of the upper part of the thigh. In this position the rupture passes down a canal by which blood-vessels pass to the thigh. The former is called **inguinal** hernia, the latter **femoral** or **crural**. Hernia may occur in children at the navel (umbilicus), and is called **umbilical**. It occurs here before the opening is properly closed up which existed for the connection between mother and child by means of the cord.

It is at the parts naturally weaker than others that rupture tends to take place, and it is usually owing to extra pressure exerted on these weaker places that they yield and permit the rupture to occur. Thus sudden straining by lifting a weight, rowing, &c., or the great pressure exerted on the walls of the belly by frequent cough, as in bronchitis or whooping-cough, &c., produces it. The rupture is called **reducible** if it can be returned the way it came into the cavity of the belly, and **irreducible** if it cannot be returned. Another form is called **strangulated**, where constriction occurs.

Symptoms.—There is the presence of a soft swelling. When the patient stands it increases in size, and when he coughs, the hand surrounding it feels an impulse. If the swelling be formed by the bowel, wind may be felt passing through it. When the person lies down, gentle pressure upwards in the direction of the groin, along with a sort of kneading motion, diminishes its size, if it is reducible, and it passes up into the belly, gradually at first, but at last with a bolt and gurgling noise. If it is irreducible, for instance by adhesion having taken place between the bowel and the canal, it cannot be returned, but wind and fæces still pass along the channel. A **strangulated** hernia is a much more serious affair. Here the channel of the bowel is blocked, either because it has got twisted or caught at the neck because of the small opening through which it has passed, or for some other reason. Not only are the contents of the bowel prevented passing along, but the circulation of the blood in the walls may be seriously hindered. The strangled bowel will, therefore, become congested and inflamed. The symptoms are thus those of stoppage of the bowels and of inflammation. Besides pain, vomiting soon occurs, first of the contents of the stomach and of bile, then of matter like that of stools—stercoraceous vomiting it is called. This kind of vomit should at once show the nature of the mischief, and should lead to the promptest action. The tumour becomes swollen and painful, the patient becomes very anxious, and, if not relieved, quickly begins to fail, the pulse grows small and wiry, the skin cold, and features pinched, and death speedily occurs, perhaps within a few hours after the strangulation.

Treatment.—The protrusion must be returned, if possible, into the belly and kept there. In the case of a reducible hernia this is often easy. The patient lies on his back, with his hips supported and his knees bent, to relax the belly. The tumour is taken in one hand and gently compressed and urged upwards in the line of the groin, a kneading movement being practised till it returns into the belly; a pad is then to be fitted over the place to prevent its return. Pads are made for the purpose, called *trusses*. They are pads kept in place by a strong spring band that passes round the body. A truss should be of the proper size, and carefully fitted over the place out of which the rupture comes. They should be regularly taken off, and the part sponged, dried, and dusted to prevent fretting of the skin; but the patient should be lying down when this is done, to prevent the coming down of the tumour.

In a woman a rupture in the upper part of the thigh must be gently pressed, not upwards, but slightly downwards and backwards, because, after escaping from the canal through which it comes, it bends upwards towards the belly. Strangulated hernia requires immediate relief, and a surgeon should at once be summoned. Till he arrives the patient should lie on the back, with the hips high and the shoulders low, to take off pressure, the knees being bent up. Iced cloths or an ice-bag, separated from the skin by a fold of flannel, should be placed over the tumour, but not kept on till the part is too cold. The surgeon may be able to relieve the patient by the aid of chloroform without an operation, which, however, is often necessary, and is rather to be welcomed by the patient in view of the serious risks delay gives rise to.

The best way to prevent a strangulated hernia is never to permit a rupture to remain down, however used one may be to it, as strangulation may arise in an old rupture which has given no trouble.

Again, if anyone is seized with sudden pain and vomiting, rupture should be examined for. These symptoms are sometimes caused by a rupture not quite down, and needing careful examination for its detection.

DISEASES OF THE RECTUM AND ANUS.

Fissure of the Anus is an extremely painful affection caused by a small crack or ulcer. The pain on passing the motions is intense, and lasts for a considerable time afterwards. The crack or fissure may be very trifling, but is just within the anus, where it is grasped by the circular muscle or sphincter which keeps the bowel closed. It is its position that makes it so painful. A careful inspection of the parts will reveal its presence. The pain caused during and after going to stool leads those troubled with fissure to delay as long as possible, and thus tends to create costiveness and similar troubles.

Treatment.—The object of treatment is to ensure rest of the sphincter muscle for a few days, since it is its movements that prevent the ulcer healing. Therefore complete division of the muscle by the knife was found the most effectual treatment. It was found, however, that division of the fibres of the muscle just under the ulcer was sufficient. This has been further simplified by simply stretching the anus forcibly, so as to paralyse the muscle for a little time. This is done by passing up the well-oiled thumb of each hand into the rectum, and then, by stretching the fingers over the buttocks and pulling on them, the thumbs are drawn apart and the sphincter forcibly stretched. This is all that need be done. It is not even necessary that the patient should be confined to bed.

Ulcer of the Rectum is higher up than the preceding. It produces uneasiness in the rectum, and a desire to go to stool, especially on rising in the morning. At such times what passes may be streaked with blood or contain matter, or the motion may be of the coffee-ground appearance, significant of blood being mixed with it. This ulcer, not being so low down as the preceding, will not be visible to ordinary inspection. A surgeon would probably require to give chloroform before making a satisfactory examination.

The treatment consists in clearing out the bowels well with castor-oil. Thereafter various kinds of injections may be used to heal the ulcer. Without surgical advice one should use only an injection of tepid water, or of thin arrowroot and water, or thin starch and water, employing a pint of the solution after every motion. The division of the ulcer may be necessary before it heals.

Piles (*Hæmorrhoids*) are a form of varicose veins (p. 326). They consist of folds of the lining membrane of the bowel which are swollen, thickened, and congested, and contain enlarged vessels. If they have grown to any extent they are forced out by straining at stool, and the pressure thus occasioned may cause them to bleed. They may thus form little tumours of the size of a pea or a nut, which produce great discomfort and pain. This is the form called **internal piles.**

They are caused by anything which produces overfulness of the veins of the belly. Thus anything interfering with the return of blood to the heart will tend to produce them, congested liver, pressure on the large veins such as is frequently exercised by the pregnant womb, &c. Luxurious living, with lack of exercise, and costiveness, produce them.

External piles or blind piles are little masses at the margin of the anus, consisting chiefly of overgrown skin and connective tissue.

Symptoms.—There is pain at stool, with heat, and throbbing, and straining, and often with the discharge of blood. Irritability of the bladder may be produced, and in women irritability of the womb with discharge. The general health may be affected, and the complexion become sallow, the liver, stomach, and bowels become deranged, and loss of flesh may result. Sometimes, after being forced down at stool, the piles may become so swollen and engorged by the pressure that the person is unable to return them, and they remain down, bleeding perhaps and exquisitely painful. They are, if not returned, liable to slough.

Treatment.—The bowels must be moved regularly, and the motion must be soft and easy to save pain and straining. For this purpose perhaps nothing is better than the old sulphur electuary, made of 4 ounces of sulphur, 1 ounce of cream-of-tartar, and 4 ounces of syrup or treacle, of which a tea-spoonful, or the quantity that is found necessary, should be taken every morning before breakfast. After each stool the parts should be sponged with cold water, and then an ointment of galls and opium applied—the gall-and-opium ointment of the chemists. An injection of cold water into the rectum both before and after stool is useful. The food should be plain and nourishing, no highly spiced, very fat, or sweet dishes being allowed. If piles cannot be replaced after they have come down, iced cloths should be applied till their size is so reduced that replacement is possible. If they have become strangled and tend to slough, poultices must be employed, the pain being relieved by opium (1 grain for a dose). The radical cure is removal, which can easily be done by operation.

Bleeding from the Rectum sometimes occurs as the result of piles. The blood may be noticed in the stools, in which case the blood is separate from the fæces, not mixed with them, and is of a red colour.

Treatment.—If the bleeding be not excessive in amount, a course of gentle opening medicine should be adopted, such as the daily morning use of a mineral water like Hunyadi Janos or Carlsbad. Where the blood is spouting, however, it must be stopped. This may be accomplished by pieces of lint pushed up the rectum one after the other. Each piece must, however, be connected with the outside by a piece of string or in some such way, so that, on removing them, one may with certainty know that none has been left behind. The lint may, if necessary, be steeped in some astringent solution—glycerine and tannic acid in solution being preferred.

Abscesses near the rectum may be caused by various circumstances, among them by piles. They are attended by pain, throbbing, and swelling round the anus. If large, they may produce serious disturbance of general health, fever, sickness, &c. They are to be treated on the same lines as any other abscess would be treated (see ABSCESS), that is, with hot applications, &c., the abscess finally to be opened and cleaned out.

Fistula in the anus is that condition in which a channel passes from the outside inwards along the side of the anus, and finally opens into the bowel at some distance from the outside. It is thus a canal with two openings, one at its inner end into the bowel, the other on the surface near the anus. Fistula is a common result of an abscess at the side of the anus. A discharge comes from it, and fæces are apt to pass through it, hence the difficulty in the way of its healing. Sometimes there is an opening near the anus from which a canal leads inwards, but terminates without opening into the bowel. This is called a blind fistula. It is a remarkable fact that fistula is common among patients affected with consumption. It is a popular notion that in such a case curing the fistula and stopping its discharge will seriously harm the patient. This is a gross error. The curing of the fistula must benefit the patient's health.

The proper treatment of fistula is by a surgical operation. The fistula is alongside of the anus, and any tendency to heal will be thwarted by the movements of the muscle of the anus. The operation divides this muscle, opens up the channel, and permits it to be thoroughly cleaned. The part is thus kept at rest and is accessible to proper dressing, so that it is in a good position for healing. Apart from this treatment, cleanliness by frequent bathing, &c., is the only thing that is necessary.

Falling of the Bowel (*Prolapse*, or *Coming Down of the Bowel*).—This consists of the protrusion of the lower part of the bowel beyond the anus. It is common in children (see DISEASES OF CHILDREN) and in old age. It is caused by straining as a result of costiveness or of diarrhœa, or as a result of the irritation of worms, &c. It may be due simply to want of tone of the bowel.

The part that comes down is of a deep-pink colour, with wrinkles and folds, and is to be distinguished from piles, which are dark, swollen, and livid.

Treatment.—The part must be returned after being gently bathed with tepid water. The fingers are well oiled and used to push the bowel back. No force must be exerted, however. Usually it slips back easily. If it is swollen and tender it will be more easily returned after bathing with cold water. To prevent its recurrence straining must be avoided; costiveness and other irregular conditions of the bowels must, therefore, be rectified. To restore the tone of the part cold sponging and the administration of tonics, especially iron tonics, are to be employed.

Itching of the Anus (*Pruritus*) is very troublesome, and afflicts elderly people, and specially those of a gouty disposition, those addicted to high living or to drink, or who suffer from want of exercise. The region round the anus may be all scarred and raw with scratching.

Treatment.—First and chiefly let the diet be properly rectified. Let the person be sparing, and use plain food, free from alcohol, coffee, and seasoned dishes, and let exercise be freely taken. Saline medicines—seidlitz-powder and such aperients—should be used frequently if necessary. The parts should be bathed regularly with cold water, and then with a lotion made of corrosive sublimate 2 grains, glycerine $\frac{1}{2}$ ounce, water $\frac{1}{2}$ ounce. An infusion of tobacco is also a good application. Note that in children worms are a frequent cause of itching at the anus.

Foreign bodies in the rectum may consist of substances that have come down from above, gall-stones, fruit stones, &c., or substances like coins, pins, &c., which have been swallowed by accident or design, or of substances pushed up through the anus. Sometimes hardened masses of fæces lodge in the rectum.

Treatment.—The substances must be removed through the anus, which must be properly widened for that purpose. This may be done by introducing several fingers well oiled. If the hand be small and properly oiled, with care it may be introduced altogether. No force must be used. With time and patience widening will take place. Sometimes a spoon has to be used for scooping out hardened fæces. If the substances are difficult to dislodge it is well to try the effects of a strong current of soapy water from an injection syringe before resorting to such an instrument as the spoon. The use of the syringe for a considerable time may ultimately loosen the impacted substances and permit their removal. Unless it be absolutely necessary none but a qualified surgeon should undertake such cases.

Tumours of the rectum are often indicated by the peculiar shape of the solid motions passed by the person. The tumour may block the rectum to a considerable extent. Cancer is one form of tumour. It is happily not common. It is needless here to discuss tumours of the rectum, since the services of a surgeon are indispensable.

Wounds and Bruises about the anus must be treated as they would be in any other neighbourhood. (See WOUNDS, &c.)

DISEASES OF THE LIVER.

Congestion of the Liver.—The structure of the liver has been described at page 200, and the way in which it is permeated with blood-vessels has been noted. Normally the liver contains about one-fourth part of the total amount of blood in the body. It can be understood, however, that if these numerous blood-vessels, instead of being ordinarily filled, were choked with blood, the liver might contain an enormous amount, and that, if it could be seen in that condition, it would appear of a deep red colour, and would feel hard and tense owing to the amount of blood contained in it.

The liver may be congested from various causes. Anything which prevents the blood, returning from the liver, passing on to the heart, and from that to the lungs, will produce an accumulation of blood in the liver. Thus heart-disease and disease of the lungs act. It may, however, result from much simpler causes—excess in eating or the use of too rich foods, excess in drink, want of exercise. It is very common in people of sedentary habits. Very hot weather occasions it. Malarial disease, ague, &c., produce it. Chronic enlargement or **hypertrophy** of the liver may result from long-continued congestion.

The **symptoms** are weight and fulness in the region of the liver. Reference to Figs. 100 and 104, pp. 190 and 198, will show the limits of that region. The organ becomes enlarged and tender on pressure. This tenderness is often well shown by giving a smart push with the fingers to the front of the belly just beyond the end of the breast-bone. As mentioned on page 200, the liver should be completely covered in by the ribs when the person lies down, except at the part beyond the breast-bone. In enlargement the liver projects beyond cover of the ribs, and its firm edge may often be felt by the fingers. Physicians are in the habit of defining its limits by percussion, as described on p. 266. The sound given out by tapping with the fingers over the liver is dull, while other parts of the belly give forth a clear sound. Thus the boundary of the liver can be ascertained. In congestion there is also some pain, especially on coughing and when lying on the side, pains often also about the right shoulder. Added to this are dyspeptic symptoms, a feeling of sickness, bad appetite, often dull headache, and mental depression. The urine is highly coloured, and there is costiveness. Sometimes there is slight yellowness of the skin—jaundice, seen first in the white of the eye.

Treatment.—Let any discoverable cause of the condition be removed if possible. Thus let plain food take the place of rich stimulating dishes. Let all alcoholic liquors be abstained from, and let regular exercise be taken. Hot applications over the liver will often greatly relieve the sense of weight and the pain. As to medicines, they should be chiefly medicines that will relieve the bowels, saline medicines like seidlitz-powders, Eno's salt, &c. Stout people are liable to be troubled with this condition of liver. They will find great relief by avoiding fatty food, sweet dishes, pastries, &c., and by taking every morning a dose—the quantity they find most convenient—of a mineral water like Hunyadi Janos, Carlsbad, or the waters of Harrogate or Cheltenham. If additional purgative is required the resin of podophyllin is preferable. One or two pills (¼ grain in each) may be taken occasionally at bed-time, or a breakfast pill of ⅛ grain of podophyllin and ⅙ extract nux vomica may be taken every morning. Mineral acids, for example dilute nitro-hydrochloric acid (20 drops), are valuable, and may be combined with the dandelion juice (a tea-spoonful), the dose to be taken twice or thrice daily a little time after food. In India, chloride of ammonium (sal ammoniac) is largely used in doses of from 5 to 20 grains several times a day, and continued for a long period.

Inflammation of the Liver (*Hepatitis*) is frequent in hot climates, and is closely connected with dysentery, in the course of which disease it often occurs. But inflammation of the liver may also occur from injury—a violent blow on the right side, &c. It may also result from the presence of poisons in the blood, such as phosphorus or the poison of syphilis, &c., or it may be a consequence of other diseases. It may be acute or chronic.

In inflammation of the liver there is, as in congestion, a much greater quantity of blood in the organ. But it is not there simply because it is prevented flowing on quickly enough; it is there because there is an active determination of blood to the inflamed organ. As a result of the inflammatory material which exudes from the blood-vessels, matter may be formed in the liver, and an abscess may result.

The **symptoms** of the acute form are similar to those described under congestion. There are pain and swelling of the organ, pains in the right shoulder, and sometimes down the arm, indigestion, sickness, hiccough, &c., and also fever, which may be slight or severe according to the degree of the inflammatory action. Jaundice is not common, though a slight degree may be present. The movements of breathing increase the pain felt in the side, and this leads to the breathing being short and shallow, and to a short dry cough. No special symptoms indicate the formation of an abscess, though chills and fits of shivering (rigors), occurring in the course of the disease, are strongly suggestive of it. Where the abscess forms in front, a swelling may be evident through the abdominal walls. An abscess is a very serious complication. It may burst into the cavity of the belly, or into the lungs, and be spat up; or it may burst in other directions.

Treatment.—The patient must be kept in bed. The diet must be light and not stimulating—milk and light soups, fat being removed, &c. Hot applications are to be freely used over the region of the liver. Nothing special can be done for the pains in the shoulder, since with the relief of the liver they will disappear, but not till then. Saline purgatives, as recommended for congestion, are to be employed. The addition to the saline medicine of infusion of senna (2 table-spoonfuls) will help its action. The flow of urine should be encouraged by the use of draughts of hot water, a tea-cupful at a time given 5 or 6 times a day. During recovery, change of air, proper food, and the use of dilute nitro-muriatic acid, as recommended for congestion, will be beneficial.

A physician will often advise the opening of an abscess which has formed, and the operation is now performed with great care and success, owing to improved methods of procedure.

The *chronic* form of the disease of the liver is of various kinds. The acute attack above described may end in the chronic disorder, or chronic inflammation may be due to various other diseases. Other forms of chronic disease of the liver are spoken of under CIRRHOSIS.

Its **symptoms** are similar to those already described, but of a milder type.

Its **treatment** is practically the same as that for congestion—plain food, moderate exercise, saline purgatives, and the dilute nitro-muriatic acid, or the chloride of ammonium.

Cirrhosis of the Liver (*Hob-nailed Liver, Gin-drinker's or Drunkard's Liver*).—The word cirrhosis is derived from the Greek *kirros*, yellowish, because in this disease the liver is of a grayish-yellow colour—the colour of impure bees'-wax. The phrase "hob-nailed" is applied because of the irregular surface of a liver affected with the disease; and the term "gin-drinker's liver" points to the fact that constant spirit-drinking (not necessarily of gin) is one very common cause of the complaint. It sometimes occurs, however, in people quite independently of spirit-drinking, and it has been known to occur in children. Cirrhosis may also, and often does, arise from syphilis.

In the disease the fine connective tissue, acting as a sort of framework for the liver cells (p. 200), increases in amount. The result is slight enlargement of the liver at first, but the newly-formed tissue contracts gradually, until, in the end, the liver is much reduced in size. There is, in fact, **atrophy of the liver.** It is the contraction that produces the irregular surface suggesting the term "hob-nailed." One evil consequence of the growth of this tissue among the cells, and its gradual contraction, is that the cells are pressed upon, so that their normal nourishment is impaired, and they waste and disappear.

The **symptoms** are none of them such that any but experienced persons could trace to their proper cause — indigestion, loss of strength, growing thinness, sallow complexion. Troublesome piles are common. Sometimes there is diarrhœa, though sometimes costiveness, and the motions are usually pale. There is never serious jaundice. The occurrence of dropsy of the belly is frequent, as well as the passage of blood from the bowels, because, as the disease progresses, the contraction of the liver hinders the due return of blood to the heart, and thus causes engorgement of the abdominal blood-vessels. The occurrence of abdominal dropsy in a constant drinker should lead one to suspect this disease at once. With these symptoms, percussion (p. 271) shows the liver to be diminished instead of increased in size. The disease may last for years before it cuts off the patient.

Treatment.—Spirit-drinking must be entirely stopped. It is to be remembered that constant tippling is even worse in the production of the disease than occasionally getting drunk. This is the main point in the treatment. The other treatment to be adopted is practically the same as that already recommended for congestion. Dropsy, bleeding, &c., are to be treated as noted under these diseases.

Inflammation of the Bile-ducts (*Catarrh of the Bile-ducts*).—This is usually a result of cold, and frequently accompanies gastric catarrh, or cold in the stomach.

Its **symptoms** are indistinguishable from those described as belonging to gastric catarrh (p. 233); they are disordered stomach, loss of appetite, flatulence, pain or uneasiness across the belly and towards the right side, sickness, vomiting, white-coated tongue, and fever. The only additional thing is that after some days, perhaps a week or more, jaundice comes on, and there is tenderness or pain over the liver. The first appearance of the yellow tinge of jaundice is to be looked for in the whites of the eyes. The jaundice and pain are both due to the same cause. The bile-ducts are not very wide channels, and the inflammation causes swelling of the lining membrane, and thus blocks the passage. The bile is therefore prevented from flowing into the bowel, and, being dammed up in the liver, causes swelling and tenderness. The absence of bile in the bowel produces costiveness, flatulence, and clay-coloured or white stools, &c. After a time the bile, failing to escape from the liver, is picked up again by the blood-vessels, gets into the blood, and causes the yellowness of the whites of the eyes and of the skin, and a dark colour of the urine, in which the presence of bile may be detected.

For **treatment**, consult what has been said about gastric catarrh (p. 233), and add to it that hot applications are useful over the liver.

Obstruction of the Bile-ducts may be produced by inflammation, the swelling and thickening blocking the channels. It is often due to gall-stones, which pass down some distance and finally stick altogether, and to various other causes, a growth for instance pressing upon the bile-duct from outside. Reference to Plate XIV. will show how any growth at the small end of the stomach or the commencement of the small bowel might easily do this. Some of the smaller ducts in the liver only may be obstructed, or it may be the duct from the gall-bladder. The worst case, of course, is where the hepatic duct (p. 201), or the common bile-duct, is obstructed, since then the bile cannot flow out of the liver at all. In such cases the bile gets pent up in its channels, unable to escape, and as the liver goes on producing bile the liver speedily becomes engorged with bile, and all the channels become widened with the pressure of the fluid. The liver, therefore, gradually enlarges. This goes on for a certain time till the pressure of fluid in the bile-channels becomes so great as to act back on the liver-cells. The cells become degenerated in consequence, and the liver gradually ceases to form fresh bile. That which has accumulated becomes changed in character by materials being absorbed, picked out of it, and passed back into the blood. In the end, after several months, the liver shrivels, wastes, and becomes flabby. Death may result from complete obstruction in a few weeks, though life may be prolonged for several years.

The **symptoms** are chiefly intense jaundice, costiveness from the absence of bile in the bowel, the motions being of the colour of clay, inability to digest fat, and various other symptoms described under JAUNDICE (p. 274). Pain, biliary colic, due to the attempt of the bile passages, by contraction of their muscular walls, to force the stone along, occurring in spasms, of a very agonizing character, beginning in front on the right side and between the navel and the margin of the ribs, and thence radiating downwards, upwards, and through to the back, is very typical of obstruction by gall-stone. The enlarged liver may be felt by the fingers, projecting from under cover of the ribs. It is needless to detail symptoms or treatment here, since the case will tax the powers of a skilful physician. The stone can be removed by operation.

The treatment consists mainly in attending to the general health, avoiding fatty foods and alcohol, taking moderate exercise, &c.

Biliousness is a favourite complaint. Many people, whenever they are troubled with headache, sickness, or vomiting, attribute their illness to "an attack of the bile." A man drinks too freely some evening, and rises with a severe headache next morning, or perhaps doesn't rise next morning because of a severe headache. He tells his friends, his business associates, or his employer that he had a "bilious headache." Many who do not know what it is to practise self-restraint in eating, drinking, or in any other direction, are loud in their complaint of "the bile," that baneful juice that deprives them of all pleasure in life. Biliousness is thus not only a favourite, but also a convenient complaint.

Now it may be that sometimes an excessive amount of bile is poured out of the hepatic duct, which, as we have seen (p. 201), opens into the small intestine a few inches below the stomach. In such a case some of the bile may readily find its way up into the stomach, provoke vomiting, and lead to loss of appetite for a time, because the stomach is unaccustomed to its presence. This is, perhaps, not unlikely to happen after a long fast, during which bile has been formed by the liver and has not been required. The accumulated bile may, therefore, for little reason, discharge itself into the intestine, and, meeting with no food to use it, may give rise to so-called bilious symptoms. It may, however, be set down as a rule that this is not a common occurrence. In short, biliousness is simply a common term employed for various and different affections, most of which we have already considered. Thus nausea and sickness, with loss of appetite, a dull headache, and perhaps a slightly yellow tinge of the whites of the eyes, are symptoms akin to those described under CONGESTION OF THE LIVER, and are to be treated as there advised.

The symptoms may also be due to chronic biliary catarrh (p. 272), or to gall-stones (p. 274).

Again, many people, specially women, are troubled with regularly recurring attacks of severe headache, with intense sickness and vomiting. The vomit is at first of the contents of the stomach, but is soon tinged with bile, and the attack is at once ascribed to bile. After some hours' or a day's suffering the headache and sickness gradually subside under the influence of quiet rest in bed in a darkened room. Now this is not biliousness. It is probably an attack of what has been described on page 169 as sick headache, or megrim, or brow-ague, and is to be treated as there recommended. The presence of bile in this case is easily accounted for. It only appears after vomiting has occurred once or twice. The pressure exerted on the gall-bladder by the efforts of retching forces the bile into the small intestine and up into the stomach, from which it passes with the vomit. It is not the presence of bile that causes the vomiting; it is the continuance of the vomiting that causes the presence of bile in the stomach.

There are many vague symptoms which people ascribe to biliousness: bad appetite, bad taste in the mouth, irregular or costive bowels, a tendency to dull headache, which may be the symptoms of slow digestion. A saline purgative in early morning, and in general the treatment advocated for indigestion will probably relieve this condition. The meals should be reduced in quantity; fats, starchy foods like potatoes, arrow-root, rice, sugar and sweets, should be avoided. Meat should be taken sparingly, and vegetables and fruits freely. Between meals a full interval should occur, 4½ to 5 hours, and a tumbler of hot water, with a quarter tea-spoonful of bicarbonate of soda should be taken an hour before each of three meals. Exercise should be freely engaged in.

To repeat, biliousness is a popular name for a great variety of complaints. By carefully examining the symptoms in the light of what has been here stated one may arrive at an idea of the probable cause of the trouble, and be able to better the condition.

Jaundice (*Icterus*) is probably derived from the French *jaune*, yellow, because of the yellowness of the skin, characteristic of the disease. It is caused by such obstruction as has been already noted, or by a tumour, cancer for example, pressing on and closing the ducts, or by such diseases of the liver as congestion. In these cases the liver forms the bile, which, however, is not permitted to escape into the bowel. In other cases jaundice occurs during the course of some other disorder, such as yellow fever, relapsing fever, and some forms of blood poisoning. It appears that powerful mental emotion may produce it, probably because of spasmodic closure of the bile-ducts.

The **symptoms** are due to the fact that the bile, not being able to pass into the bowel, is absorbed into the blood and distributed throughout the body, staining the tissues through which it passes. The chief is yellowness of the skin, varying from a mere sallowness to a golden-yellow or bronze tint. Sometimes in extreme cases the sweat stains the clothes. The urine is coloured also a saffron-yellow or a dark-greenish colour, or any degree of yellowness between these, owing to the presence of bile. The whites of the eyes are deeply coloured, and in them the first signs of the approaching jaundice may be detected. Along with these are symptoms due to the want of bile in the bowels, costiveness, the motions being pale and like clay in colour, and having a very bad smell, sickness and vomiting, hiccough, flatulence, inability to digest fat, and perhaps the passage of fatty matter in the stools. Resulting from the presence in the blood of improper materials are itching of the skin and perhaps eruptions, feebleness of the heart, exhaustion, drowsiness, giddiness, and lowness of spirits, &c. It is not common for a jaundiced person to see things as if they were yellow, though this is a popular notion. Jaundice occurring in newly born children is considered under DISEASES OF CHILDREN.

Treatment.—Jaundice arising from congestion of the liver, inflammation of the bile-ducts, &c., must be treated accordingly. Often it will be relieved by 5 grains of calomel, followed by a full dose of castor-oil or senna. Many of the worst cases arising from obstruction are incurable, and the patient must simply take light food without fat or stimulants, must have moderate exercise, and may occasionally take a warm bath to help the skin. But, jaundice being a sign of disease rather than a disease in itself, it is necessary to discover its precise cause in order to treat it properly. An accurate determination is often extremely difficult.

Malignant Jaundice (*Acute Yellow Atrophy of the Liver*).—This is a rare affection, in which the cells of the liver (p. 200) are rapidly destroyed. The disease is usually sudden in its onset, accompanied by jaundice, vomiting, and intense headache, and delirium. A feature of the disease is the absence of bile from the motions. The bile ceases to be formed by the liver. This condition is called **acholia** (Greek *a*, want of, and *cholē*, bile). There is a great tendency to bleeding, blood being poured out in little patches under the skin, and being also vomited. Death is seldom delayed beyond a week.

Gall-stones (*Biliary Colic*) are little masses formed of the colouring matter of the bile. They are usually produced in the gall-bladder, probably from stagnation of the bile and consequent deposit of the colouring matter. They are of a dark-brown colour usually, and may be very small, like grains, when they are spoken of as "gravel;" or may attain a variety of size, that of a pea or bean, or even larger. There may be only one stone or several; if several, the stones are not round, but flattened on the sides by contact with one another. A gall-stone may become dislodged from the gall-bladder, and proceed to force its way down the cystic duct (p. 201) towards the bowel, giving rise to biliary colic. Gall-stones are more frequent in women than men, and they occur usually after the age of thirty.

Symptoms.—Severe pain comes on suddenly, and may be so intense as to cause the patient to cry out in agony. It is described as cutting or tearing, and is felt in the neighbourhood of the pit of the stomach or navel, and extends lower down and through to the back. It lasts a varying time and then ceases, only probably to return some time later. It thus occurs in spasms. It causes sickness and vomiting, faintness, and often actual fainting. If the gall-stone block the bile-duct, costiveness is likely to arise and the stools to be clay-coloured; and jaundice appears after a day or two. The gall-stone may be arrested in its passage along the bile-duct, and may remain in this position, completely blocking the duct, in which case the symptoms of obstructed bile-duct are developed. The only conclusive evidence that the spasms have been caused by a gall-stone is the finding of a stone in the motions. To effect this the motions must be carefully examined in the manner described on p. 240. If the stone have escaped from the bile-ducts into the bowel, it is often two or three days after the last spasm before it is passed in the motions, so that the fæces should be examined for a number of days after the attack has passed. A person who has had one attack of biliary colic is always liable to another.

Treatment is devoted to relieving the pain and aiding the passage of the stone, by placing large hot poultices or hot bottles over the belly, and by the use of opium; 1 grain of the latter may be given at a time, repeated as often as may be necessary, the patient being carefully watched to see that too much is not being given. The injection of $\frac{1}{6}$th of a grain of acetate of morphia under the skin or the use of chloroform will relieve more quickly. Painful vomiting may be relieved by draughts of warm water containing a tea-spoonful of carbonate of soda to the pint.

Recurrence of an attack should be avoided by plain food, moderate exercise, and the daily morning use of Carlsbad mineral water or Vichy waters.

Degenerations of the Liver, Fatty Degeneration (*Fatty Liver*).—In this affection the liver cells become crowded with globules of oil, which ultimately increase to such an extent that the cells become sacs of oil. The liver becomes large and pale. Fatty liver will result from overfeeding, especially if fatty food form a large part of the diet. Its occurrence is aided by want of exercise. It is also present in consumption; it may be a result of constant drinking, or of syphilis and other diseases. It occurs in phosphorus poisoning.

Its **symptoms** are of no special character, but resemble those of chronic indigestion.

Treatment is that of congestion (p. 270).

Waxy Liver (*Lardaceous Disease or Amyloid*).—Syphilis and scrofula lead to this degeneration, in which the substance of the liver becomes converted into a dense glistening material like yellow wax. It may result from the presence of any prolonged discharge from some sore or from disease of bone. Its nature and symptoms are too obscure to be treated here. One of its results is that the liver may attain to an enormous size.

Tumours of various kinds occur in the liver. It is only necessary to note the **Hydatid tumour**, p. 261, and **cancerous tumours**. Unfortunately nothing can be done for the cure of cancer of the liver. The patient may have relief from pain, and should have what is needful to maintain as far as possible his strength, but that is all that can be done. Death is seldom later than two years from the beginning of the symptoms, and may be within six months.

DISEASES OF THE PANCREAS

The pancreas is liable to such diseases as attack other organs—inflammations, abscesses, &c., but the discriminating between pancreatic disease and the diseases of other organs in the immediate neighbourhood of the pancreas is so difficult a task that any attempt at guidance here would be useless. Reference should be made to Plate XIV., where the relationship between the pancreas and stomach and the pancreas and bowel and liver is shown.

SECTION XII.

THE GLANDULAR AND ABSORBENT SYSTEM.

ITS STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Lymphatic Vessels and Glands:
- *The lacteals of the bowel* and the nature of the fluid (*chyle*) they contain;
- *Lymphatic glands*—their structure and functions;
- *The receptaculum chyli and thoracic duct;*
- *Lymphatic vessels*, the nature of the fluid (*lymph*) they contain, their functions as absorbents, the meaning and importance of absorption.

The Blood or Ductless or Endocrine Glands:
- *The Spleen;*
- *The Thyroid Gland;*
- *The Thymus Gland;*
- *The Supra-renal Capsules;*
- *The Pituitary and Pineal Glands;*
- *The Glands of Peyer.*

THE LYMPHATIC VESSELS AND GLANDS

ABSORPTION FROM THE BOWEL.

Lacteal Vessels.—It has been pointed out on pages 204 and 205 that the blood is regularly receiving fresh supplies of material to maintain its bulk and quality from food that has been taken into the alimentary canal. It has been seen that the nourishing portions of the food gain access to the current of blood by two channels, that watery parts of the food, containing sugar, salts, &c., dissolved in them, can pass directly through the walls of the blood-vessels of the mucous membrane of the intestine, and gain entrance to the blood, but that fatty matters cannot so pass. In the small intestine, however, fat is acted on by bile and pancreatic juice, and, as a result of that action, the fat no longer floats in large globules among the food, but is made into a milk-like mixture, and is broken up into a great number of very minute globules. The fat, being scattered through the food in this fine state of division, gives it a milky appearance, from which it is called **chyle** (Greek *chulos*, juice). The chyle is separated from the contents of the intestinal canal by the villi (p. 199) of the small intestine, which project from the surface of the bowel to suck up the juices it may contain. The sucked-up juices pass into a vessel in the villus. The vessel has been called a **lacteal**, from the Latin word *lac*, milk, because of the milky appearance of the juice it contains. So that the lacteals are the second channel by which nourishing material passes from the intestinal canal. The process that we thus see performed by blood-vessels and lacteals, by which materials are picked up to be used in the body, is called **absorption** (from Latin *absorbere*, to suck up), and it is a process, as we shall see, not confined to the intestinal canal, but going on in every tissue and organ of the body. The vessels by which the absorption process is carried on are called **absorbents**. We must now follow the course of the chyle in more detail than it was convenient to do on page 204. It appears that this milky fluid which fills the lacteals is not in a proper condition to be poured at once into the current of blood. It may be it is too raw material yet, and must undergo some measure of preparation. The bowel is suspended from the back wall of the belly by means of a double fold of membrane, the mesentery (p. 190). The lacteal vessels are continued up from the bowel between the folds of the mesentery, and pass through glands which are also contained between the folds. [Refer to Fig. 124, and its description.]

Glands of the Bowel.—The glands are called the **lymphatic glands of the mesentery**, or, shortly, the **mesenteric glands**. There are about one hundred and fifty of them. In a healthy state each gland should be about the size of an almond, but in certain diseases they are enlarged, and, as has already been pointed out (p. 254), they are seriously affected in consumption of the bowels. Fig. 125 represents the structure of one of these glands. The gland has an investing coat or capsule (*a a*), which completely surrounds it. From the capsule fibrous strands (*b*, *b*) pass into the gland, dividing it off like partitions into spaces. The spaces round the circumference (or *cortex*) of the gland are of considerable size, and are more or less oval (*d*, *d*, *d*), while the spaces towards the centre (or *medulla*) are irregular in shape, and smaller (*e*, *e*). The spaces are almost completely filled with masses of material, consisting of a net-work of very delicate connective tissue, in which white cells of various sizes are entangled. This sort of tissue is called **adenoid**, or gland tissue, from the Greek *adēn*, a gland. But the masses of tissue do not quite fill the spaces. Between the outer surface of the mass and the wall of the space are channels, and the channel round one mass communicates with that of another, and those round the edge communicate with those in the centre, so that the gland might be looked upon as a mass of gland tissue broken up into numerous little clumps by a series of irregularly winding and communicating channels. The channels, moreover, are not perfect fairways. They are crossed and recrossed by spans of the delicate tissue of the gland, so that the whole structure becomes not unlike that of a sponge. Now the lacteal vessels join the mesenteric gland at the margin or outside (as shown at *f*, *f*, Fig. 125), and pour their fluid contents into the channels there. From them the fluid filters its way to the channels of the centre, bathing and penetrating the gland tissue in its course, and finally joins vessels, identical with *f*, *f*, at the centre, by which it is carried away from the gland. The outgoing vessel is represented by *g*, *h*.

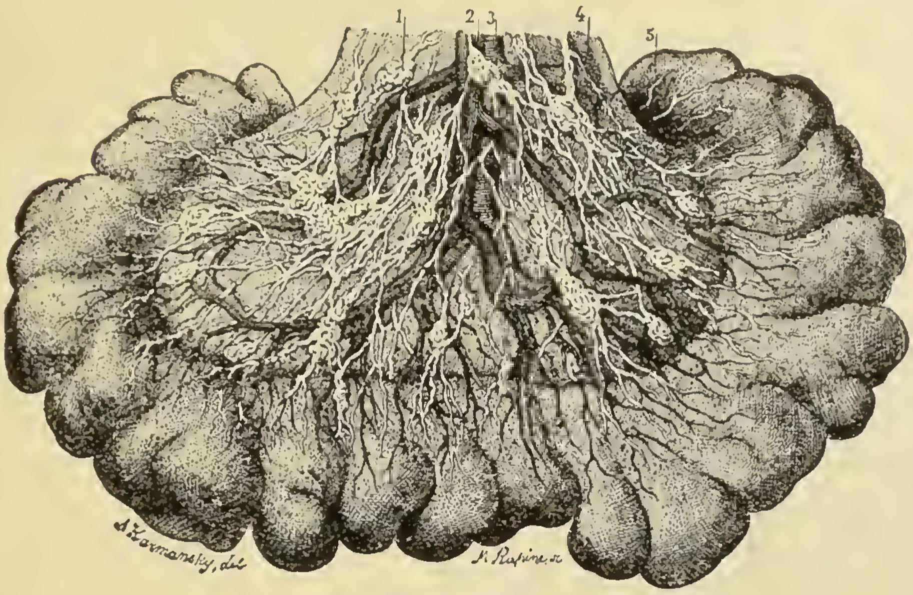


Fig. 124.—Mesenteric Glands.

4 points to the membrane of the mesentery from which the bowel (5), seen in folds, is suspended. 1 points to a gland, a large number of which are present, connected to one another and to the bowel by fine lymphatic vessels. 2 indicates a vein, and 3 an artery branching through the mesentery and over the bowel.

In this progress through the gland the chyle undergoes some important changes. Before entering the gland it was simply a milky fluid, containing very fine particles of matter in suspension, and being incapable of coagulation, or clotting, when heated; but, on leaving the gland, it is capable of coagulation, and contains numerous white cells, which have been swept away from the gland tissue by the stream. It will now be evident how liable the lymphatic glands are to be irritated and thrown into a condition of inflammation. Suppose the ingoing vessels carry with them irritating material, it filters through the whole gland, irritating in all its course, and swelling and inflammation result. Sometimes this may save the rest of the body. It may be that the gland not infrequently intercepts, like a filter, material which, if permitted to go on, and finally to pass into the blood, would affect the whole body, but which, caught by the gland, expends its whole force on it, so that while the gland suffers the rest of the body escapes. Having issued from the gland, the chyle flows onward in lacteals in the mesentery till it is poured into the receptacle for the chyle, **receptaculum chyli** (2, Fig. 126). This receptacle is a sac-like expansion at the lower end of a duct—the **thoracic duct** (1, Fig. 126). Not only do all the lacteal vessels pour their contents into the receptacle, but other vessels—lymphatic vessels of the lower limbs, to be described immediately—also join it. It lies on the front of the spinal column at the level of the upper lumbar vertebræ (p. 60). From the receptaculum chyli the thoracic duct passes

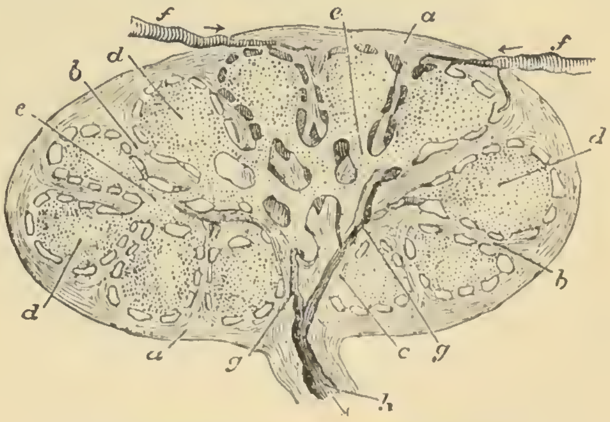


Fig. 125.—The Structure of a Lymphatic Gland.

upwards along the front of the spine through the cavity of the chest to the root of the neck. Here it curves forwards and joins a large vein from the neck—the internal jugular—just where that vein joins a large one from the arm (3, Fig. 126). So that the chyle, after passing through the mesenteric glands, is carried up to the root of the neck by the duct, and there poured into the blood. The thoracic duct is from 15 to 18 inches long, and about the size of a small crow-quill.

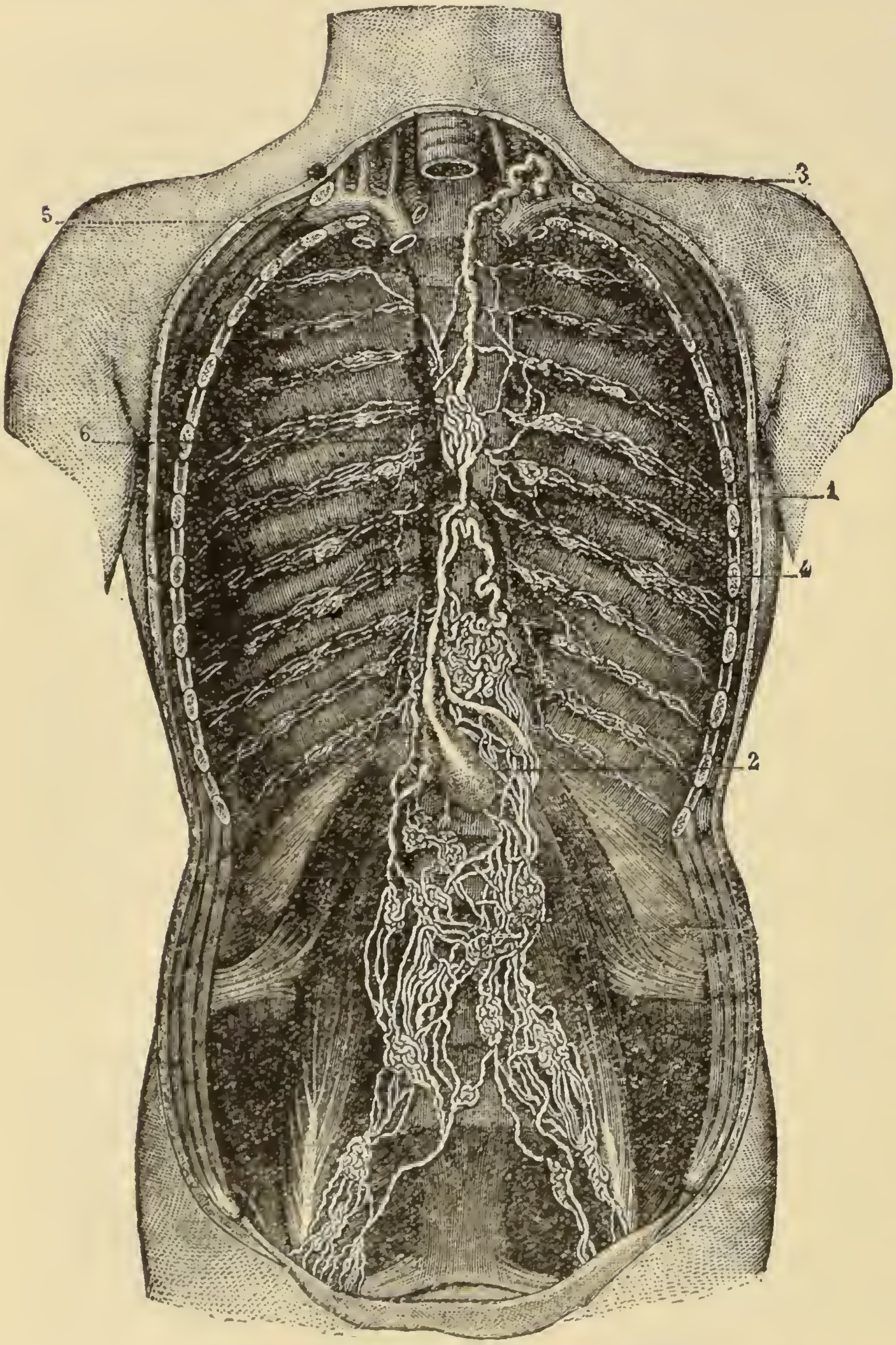


Fig. 126.—The Thoracic Duct and Lymphatic Vessels.

In the course of the lacteal vessels and thoracic duct there are valves which direct the flow of fluid and prevent it passing backwards, while a valve at the junction of the duct and the veins in the neck permits the contents of the thoracic duct to flow into the vein, but prevents the blood passing from the vein into the duct.

Fig. 126 shows the course of the thoracic duct. Lymphatic vessels are seen joining it from below, and from the walls of the chest. Glands are shown in the course of the vessels, 4 pointing to a gland of the chest wall. 5 and 6 point to veins.

ABSORPTION FROM THE TISSUES IN GENERAL.

Lymphatic Vessels.—Now in every organ and tissue there is a set of vessels, called **lymphatic vessels**, precisely similar to the lacteal vessels of the mesentery; and they are connected with lymphatic glands just as the lacteals are connected with mesenteric glands. These lymphatic vessels contain a fluid called **lymph**.

What lymph is must be properly understood. The blood flows through the whole body, being distributed in small vessels with extremely thin walls. As the blood flows in these fine vessels through a muscle, for example, it oozes through the delicate walls, so that the fibres of the muscle are bathed in the fluid, and the muscle can select the nourishment which it requires. Just as a river flowing through a large plain may be made to water the whole of it, by a set of channels being cut here and there throughout it, along which the water may be caused to flow, and be thus brought near every part of the fields. It is the presence of lymph among the tissues that gives to them their softness and moisture. More fluid escapes from the blood-vessels than may be necessary for the nourishment of the tissues. The excess must be removed. It passes into the lymphatic vessels which abound in muscle. Since the fluid has bathed the tissue, it will have picked up materials from the muscle, principally waste substances which have been produced by muscular work. This excess of nourishment, along with the waste substance removed with it from the tissues, forms lymph. The lymph is not cast out of the body; it is returned to the blood. But even as the chyle from the intestine was not in a fit condition for immediately joining the blood-stream, and was passed through the mesenteric glands to be properly worked up, so the lymph is carried to lymphatic glands, where it undergoes certain processes to fit it for being poured into the blood. Here, then, is another example of the marked economy exhibited in the body. Nothing is cast out in the ordinary healthy body that can be of further service in the system. As to the characters of lymph, they resemble those of chyle. It is a whitish fluid, slightly yellowish, clots readily, and contains white cells, like the white cells of the blood, but it does not contain the minute globules of fat that abound in chyle.

It has been said that lymphatic channels exist in every organ and tissue of the body; and perhaps it will give some idea of their abundance when it is said that it has been estimated that the quantity of fluid picked up from the tissues by their agency and restored to the circulation in 24 hours is equal to the bulk of all the blood in the body.

The lymphatic vessels unite to form larger and larger vessels, and in the end join the thoracic duct, with the exception of the lymphatics of the right side of the head and chest and right arm. These latter form a short wide trunk—the **right lymphatic duct**—which opens into the junction of the jugular vein of the right side, coming from the head, with the vein coming from the right arm, a similar position to that of the thoracic duct on the left side. In Fig. 126, 5 points to the vein formed by the junction of the veins of the head and arm. Thus all the lymphatic vessels of the lower limbs, of the belly, of the left arm, and of the left side of the head and chest, and all the lacteal vessels from the intestine, pour their contents into the thoracic duct, while the lymphatics of the rest of the body join the right lymphatic duct.

ABSORPTION FROM THE SKIN.

Now it is easy to fail to estimate the importance of the lymphatic system, and perhaps its significance will be best understood by a few examples. Let it be repeated that lymphatic channels exist in every organ and tissue; they abound in the skin. Now suppose a pin or some sharp instrument with a dirty point is introduced into the skin. The poisonous material left among the moist tissues cannot fail to be carried with the lymph into a lymphatic channel. It will be carried to a lymphatic gland, and may be there intercepted, or may filter through the gland and gain access to the blood. All this may happen in a very short time, and thus it is evident how blood-poisoning may be the result of a very small wound. Even though the material introduced into the skin be not sufficient in quantity or in violence to poison the blood, it may produce other effects. It may irritate the vessels along which it is carried, and inflammation result; and then the presence of lymphatics in the skin is speedily revealed by the appearance of fine red lines, painful to the touch, which mark the track of the inflamed vessels, while the skin in the neighbourhood of the vessels is swollen and glazed. In the same way the poison may act upon the gland. It sometimes seems to spend its strength on the gland, which becomes inflamed, swollen, and in the end an abscess may be formed, or, even if that does not result, a hard swollen mass remains to mark the attack.

Take another example — the occurrence of hard, swollen glands, popularly called "**kernels**," is common in children, particularly at the side of the jaw and in the neighbourhood of the ear. Of course something may have directly injured the gland to make it swell in this way, but if what has been said has been understood, it will at once occur to anyone that the swelling of the gland may be due to some irritating matter brought to it by a lymphatic vessel from some part a little removed from the gland. Under such circumstances, if one knows from what part of the body the lymphatic gland receives its lymphatic vessels, one may examine the whole district to see if in any part of it some irritation is present to account for the enlarged gland. This will be again referred to in speaking of inflammation of glands.

Advantage is taken of the absorbing power of the lymphatics to introduce medicines into the system. When ointment is rubbed into the skin, it is no doubt by means of the absorbent vessels that part of it is picked up and carried into the blood. The skin of some animals absorbs very readily, that of man not so readily. Still, experiment has shown that a person placed in a bath will absorb some water by the skin, and, if carefully weighed, he will be found heavier on leaving the bath than before entering it. Efforts have been made to nourish persons, who could not take food by the mouth, by means of milk baths, &c., though, from the comparatively small amount taken up, the success has not been great. Another method of administering medicines depends on the absorbing power of the skin and tissues beneath it, the method of **hypodermic injection** (Greek *hupo*, under, and *derma*, the skin). It consists in thrusting the point of a hollow needle under the skin. The needle is connected with a small syringe containing a drug in solution. When the piston of the syringe is pushed down, the fluid is forced along the hollow needle into the tissues under the skin, from which it is rapidly sucked up by the absorbent vessels and passed into the blood. Solutions of morphia are given in this way for the relief of pain. The speed of absorption is shown by the fact that within two or three minutes, sometimes indeed within a few seconds, after the injection, the pain in many cases vanishes. Again, every smoker knows that if he draws the smoke of tobacco into his lungs, he will speedily feel its effects in his head. The moist membrane of the lungs has seized upon the vapour, and its elements have been absorbed by the lymphatics, and, reaching the brain by the blood, have produced their characteristic effects. Absorption by the bowels, absorption by the skin, and absorption by the lungs are thus facts of very great importance in the body. In each case the materials sucked up are passed through glands to be worked up into a fit state for entering the blood.

BLOOD GLANDS: ENDOCRINE GLANDS.

The blood glands are the spleen, thyroid, thymus, suprarenal, pituitary, and pineal bodies. They each make a contribution of some kind to the blood which maintains its fitness to supply the material for the growth and nourishment of the various organs and tissues of the body in due balance. Therefore they are also called **organs of internal secretion** or **endocrine glands** (Greek *endon*, within, and *krinlin*, to separate).

But they do not produce, like the salivary or sweat glands, a secretion that is carried along definite channels, and so an earlier name was **ductless glands.**

Of recent years an immense amount of research has been done by physiologists and physicians to unveil the mystery of the work of these structures, adding a new chapter to medical science more fascinating than its title **endocrinology.**

The development of the sex organs is also associated with the normal function of these endocrine glands.

The **Spleen** is the chief of these. It is situated in the belly to the left side of the stomach in the hypochondriac region (p. 190). Its position in reference to the stomach is well shown in Fig. 109, p. 201, and by studying this figure in conjunction with Fig. 104, p. 198, a good idea may be obtained of its position in reference to the rest of the body. The spleen is popularly called "the melt." It weighs usually from 5 to 7 ounces, is an elongated, flattened body, 4 to 5 inches in length, and 3 inches broad. It is usually of a deep-red or a purplish colour. It is a gland of considerable importance, if we are to judge from its blood supply, for it receives an artery—the **splenic artery**—directly from the aorta, the chief blood-vessel of the body. See Plate XIV.

Its vein—the **splenic vein**—joins the portal vein, as we have already noted on p. 200. Its structure much resembles that of a lymphatic gland, already described. It has a fibrous capsule, from which partitions, or trabeculæ, pass inwards, dividing off the organ into spaces by the irregular network they form. In these spaces is inclosed **spleen pulp,** which consists of cellular bodies of various sizes—some like the white corpuscles of the blood, some larger, and others smaller. If a spleen be cut open and looked at with the naked eye, small white round bodies, like sago grains, are seen scattered through it. These are the **corpuscles of the spleen,** or the **Malpighian bodies of the spleen.** They are masses of what has been called adenoid tissue (see p. 277), consisting of white cells in a net-work of fine fibres, and through each body passes a branch of the splenic artery. Fig. 127 shows a branch of the splenic artery (*a*), with the corpuscles (*c*) situated on its twigs (*b*). The blood passes from the capillaries of the artery into fine spaces among the spleen pulp, from these to larger spaces, and then on to the veins, which carry it away from the organ. In fact the spaces are of such a character that the blood from

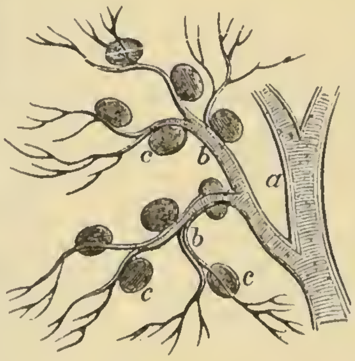


Fig. 127.—Portion of Splenic Artery, with Corpuscles of the Spleen attached to its Twigs.

the artery filters through the pulp, just as fluid would pass through a sponge, and is then collected by the veins.

Functions of the Spleen.—Such a remarkable structure suggests that the business of the spleen is to affect in some way the quality of the blood. As the blood filters through the spongy pulp, some important change is wrought in it by the active cells of the pulp, either in the way of removing from the blood-current old and worked-out red cells, or, as others believe, in the direction of adding to the blood new and active white cells, for the white cells of the spleen are not distinguishable from those of the blood. The blood coming from the spleen is said to be richer in white cells and poorer in red ones. It has been found that the spleen increases in size after a meal, being considerably swollen five hours after a meal, remaining so for some time, and then returning to its usual size. So that it undergoes a regular alternate expansion and diminution in size. When, however, it is mentioned that the spleen has been wholly removed without any apparent ill effect, it will be understood how obscure is yet the question of its function.

In ague and other malarial diseases the spleen becomes remarkably enlarged; and there is also great enlargement in a disease called **leucocythæmia**, in which the number of white corpuscles of the blood is enormously increased. (See DISEASES OF THE BLOOD.)

The **Thyroid Gland** is situated in the neck, and consists of two lobes or divisions, one on each side of the box of the windpipe, the two being connected by a cross-piece. (Fig. 133, p. 297.) It is usually larger in the female than in the male. Associated with it are smaller structures, two on each side, the **parathyroids**. The gland consists of a capsule, sending in partitions which divide off the gland into spaces, occupied by round or oval sacs or vesicles, which are lined with cells and filled with glairy contents. The gland is richly supplied with blood-vessels. A great enlargement of it is the feature in **goitre** (*Derbyshire neck*), and a peculiar form of idiocy, called **cretinism**, is associated with it. Both of these diseases are discussed at pp. 287, 289.

The destruction of the true tissue of the thyroid in the human subject by disease, or its complete removal, produces a series of symptoms, of which solid swelling of the tissue in and under the skin, general muscular weakness, as well as nervous changes, are the chief. The features are altered by the general swelling; enlargement of the hands and feet, as of the body generally, occurs. Such changes are best seen in the disease called **myxoedema**. (See Plate II.) In some animals complete removal of the gland produces similar changes, attended by a rapidly fatal issue. When the symptoms occur in the human being, grafting the thyroid of an animal into the human body, or feeding the patient with fresh thyroid of the sheep or calf, or administering a glycerine extract of fresh thyroid, or even the dried gland in the form of tabloids, relieves the symptoms. It has been, therefore, concluded that the thyroid produces something to be added to the blood, the want of which causes the disease. It is certain that the disease myxoedema has become amenable to treatment since treatment by thyroid was introduced, and to some extent the disease called **cretinism** is capable of improvement by the same means. That this gland has some marked effect on the general nutrition of the body is also proved by the fact that thyroid feeding has been of use in obesity by stimulating the chemical changes of nutrition, and also in some skin affections, such as psoriasis, for a like reason.

On the other hand, overgrowth of the thyroid causes what is called hyper-thyroidism, of which staring eyeballs, excessive rapidity of the heart, general tremor and nervous excitability, are leading symptoms. (See Graves' Disease, p. 288.)

The **Thymus Gland** also belongs to the blood glands. It also is placed on the windpipe, but lower down than the thyroid, being in the upper part of the chest, behind the top of the breast-bone. It is in its period of greatest activity before birth, beginning to waste away soon after birth. Gradually the greater part of the gland disappears, its place being taken by connective tissue and fat, so that with the end of childhood little of it remains. It consists, like the lymphatic gland, of spaces inclosing adenoid tissue (p. 277). It is supposed to have to do with the elaboration of the blood, but nothing definite is known of its functions.

The **Supra-renal Capsules** are two small bodies connected with the kidneys. They are in shape not unlike a cocked hat, and one surmounts each kidney. They are large before birth. In structure they are peculiar. The fibrous covering of the gland gives off divisions, which pass inwards, dividing it off into spaces, some of which are circular, some oval, and some small and irregular. These spaces are filled with masses of large epithelial cells (p. 55). The blood-vessels ramifying between the groups of cells are very numerous, so also are the nerves. There is a disease, called **Addison's disease**, in which there is deep bronzing of the skin, supposed to be connected with diseased conditions of the supra-renal bodies. This disease is commented on at page 290.

These bodies are supposed to affect the quality of the blood in a way similar to the thyroid gland, either by removing some toxic substance from it, or by adding some material produced within it to the blood. Complete destruction of these bodies in an animal by disease, or complete removal by operation, is followed by intense muscular prostration, and symptoms like those of Addison's disease. An extract of the capsules injected into the body produces very marked effects upon the blood-vessels, by acting upon their muscular walls, causing them to contract, and so greatly diminishing their calibre. The smaller arteries are the vessels specially acted on, and so pronounced may be the effect that for a time the flow of blood through the smaller vessels may be almost arrested, and some organs made almost bloodless. The effect lasts only a short time, however. But while it lasts the pressure of blood in the larger vessels is naturally greatly increased, because of the resistance to the flow in the smaller ones. This effect is easily seen locally, for a little of a watery extract introduced into the eye will make the lids and eyeball almost bloodless in a few minutes. This action is now largely taken advantage of for minor operations on eye, nose, and throat. For it has been found possible to extract from the juice of the fresh capsules of an animal the active principle to which this effect is due. To this active principle the name **Adrenalin** has been applied. A small quantity of it applied as a spray to eye, nose, or throat, specially if combined with a small percentage of cocaine, enables one to perform a small operation quite painlessly and without blood. Thus tonsils may be removed without the least inconvenience to the patient, growths or obstructing spurs of bone may be removed from the nose, or small growths from the eyelids, while a similar combination is extremely useful in some acute inflammations of the eyelids.

It is probable, therefore, that the supra-renal bodies maintain in circulation in the blood minute quantities of some active substance which helps to maintain the tone of the voluntary muscles of the body, as well as the tone of the involuntary muscle of heart and blood-vessels.

The **Pituitary and Pineal Glands** are small bodies situated towards the base of the brain. The pituitary body is called from *pituita*, Latin for phlegm, because it was supposed by the ancients to discharge phlegm or mucus down the nostrils. The pineal gland is a small body about the size of a cherry-stone, and is called from *pinea*, a pine. It is placed in front of the corpora quadrigemina (p. 134). Both of them are formed of epithelial cells.

Of the pituitary body it may be said that it seems to be associated in function with the thyroid gland. Results such as attend destruction of the thyroid follow destruction of the pituitary body. A very peculiar disease, called **acromegaly**, attended by great enlargement of the hands and feet, and changes in the bones of spine and face, has been shown to be associated with degeneration of the pituitary body, and feeding with the pituitary of animals has been tried as a form of treatment for this disease. It has been supposed also that degeneration of the thyroid may be to some degree compensated by enlargement of the pituitary. In any case it also appears to produce an internal secretion whose effect upon the blood affects the nutrition of the tissues, and specially of the heart, vessels, and nervous system.

The pineal gland, to call it also a gland, is more likely to be merely a vestigial structure, a remnant of a stage of development of the body.

Peyer's Glands have been already mentioned as occurring in the mucous membrane of the intestine, sometimes singly, sometimes in groups (p. 199). They are small, round, shut sacs, composed of a fibrous tissue capsule, and containing the same sort of tissue as the lymphatic gland. They are affected in typhoid fever. Because of their resemblance in structure, they are classed with the blood glands, nothing being known of their functions.

SECTION XIII.

THE GLANDULAR AND ABSORBENT SYSTEM.

ITS DISEASES AND INJURIES.

Diseases of Lymphatic Vessels and Glands:
Inflammation of lymphatic vessels (*Lymphangitis, Angioleucitis*);
Inflammation of lymphatic glands (*Adenitis*)—kernels;
Lymphatic Tumours (*Lymphoma, Lymphadenoma* or *Hodgkin's Disease*).

Diseases connected with the Spleen:
Congestion, Enlargement, &c.

Diseases connected with the Thyroid Gland:
Goitre, (*Bronchocele, Derbyshire Neck*);
Exophthalmic Goitre (*Graves'* or *Basedow's Disease*);
Cretinism;
Myxoedema.

Disease connected with the Pituitary Body:
Acromegaly.

Disease connected with the Supra-renal Capsules:
Addison's Disease.

DISEASES OF LYMPHATIC VESSELS AND GLANDS.

INFLAMMATION.

Inflammation of Lymphatic Vessels (*Lymphangitis*, also called *Angioleucitis*, from Greek *angeion*, a vessel, and *leukos*, white).—This most commonly results from the introduction under the skin of some irritating material, which, as explained on p. 279, is picked up by the lymphatic vessels, and subsequently irritates them. Medical men and students run risks of it, coming in contact as they do with so many foul discharges. The smallest break in the skin, even that made by a pin point, may afford entrance to poisonous stuff, which begins to manifest its presence within a few hours after its introduction. Injury may also set up the inflammation.

Symptoms.—The chief evidence of the disease is the presence of fine red lines in the skin. These mark out the course of the inflamed vessels. They may be traced from the place where the irritating substance has been introduced, the neighbourhood of which place is likely swollen, the skin being tight, glazed, and with a deep flush, and their course followed up to the lymphatic gland which the vessels join. Thus, suppose some irritating material, say irritating matter from some bad sore, to have gained entrance at the point of the thumb. After some hours the thumb will begin to feel stiff and painful, and will be evidently swollen and hot. As the inflammation develops, the swelling, tenderness, and redness will increase, and the redness will be specially noticed as a sort of broad band down the front of the thumb. This broad red band will be traced over to the wrist, where there is likely to be a specially swollen clump, the meeting-place of several lymphatic vessels. From the wrist bright red streaks will be seen passing upwards to the inner side of the elbow, where there is likely to be a sore spot, and perhaps they pass still upwards to the arm-pit and inflame the glands there. This is the direction the lymphatic vessels take, as may be seen from Fig. 129. The red streaks are hard, and painful when touched. As the inflammation goes on they broaden, till neighbouring streaks meet, and thus a great extent of the limb, or even the whole of it, may become swollen and painful. If the inflammation be severe, the patient is likely to have chills and shivering fits (rigors), and there are probably fever, sickness, and prostration. It may lead to the formation of matter in the course of the vessels, or may set up inflammation in a lymphatic gland, ending in abscess. The worst result is where the poison passes beyond the gland and sets up blood-poisoning (septicæmia or pyæmia), in which case death may result from the violence of the poison within a few hours. In simple cases the inflammation is expended on the vessels and on the gland, and slowly subsides after attaining its height.

Treatment.—The affected part must be kept at perfect rest. This can be properly managed only by the patient staying in bed. Warm applications are to be kept to the inflamed region. At once a large dose of saline medicine must be given, such as epsom-salts, seidlitz-powders, &c., so that a speedy and copious discharge from the bowels is obtained. These are the first and simple means to be adopted, and in uncomplicated cases are sufficient. Nevertheless, as one cannot at first judge how serious the case may turn out to be, and as within a few hours an apparently simple case may show evidences of threatening life, a medical man should at once be consulted. If that is not possible, and the fever be considerable, 5-grain doses of quinine every four or six hours should be administered, and the patient should have as a drink 120 grains of chlorate of potash dissolved in a pint of barley-water or lemonade, to be drunk within twenty-four hours. Strengthening food is of the utmost consequence in severe cases. (Refer to BLOOD-POISONING, p. 315.)

It is evident that since this disease is usually due to the introduction of poisonous material, great care should be exercised in its prevention. For this purpose, if one has received a wound from an instrument whose cleanness is suspected, or has a wound—a prick with a sharp instrument, a cut, a scratch, &c.—into which some poisonous stuff has been introduced, the part should be immediately grasped tightly nearer to the heart than the wound, so as to stop the circulation of blood in the part, the lips should be at once applied to the wound, so that it may be sucked vigorously to remove the poison, and as soon as possible a stream of pure water should be run upon it to wash it thoroughly. Not till this has been done should the grasp on the part be released, and by this time probably all injurious material has been removed. If these precautions are promptly and vigorously taken, no further treatment is likely to be necessary, unless covering the wound till it is healed, to prevent the entrance of any irritating substance at a later period.

Inflammation of the Lymphatic Glands (*Adenitis*, from Greek *adēn*, a gland).—As has been pointed out in the preceding paragraphs, this is a frequent result of inflammation of lymphatic vessels, owing to the same substance that irritates and inflames the vessels being carried to the gland. Of course, in such cases, the cause of the glandular affection is obvious, because there is the preceding inflammation of the vessels. In many cases, however, a gland may become inflamed and swell without any previous indications of the disease proceeding onwards in the track of the vessels. They have conveyed material to the gland which has irritated it, while they themselves have escaped. Thus swellings of glands are common in children in the neighbourhood of the jaw, behind the ear, and towards the back of the head. These are frequently due to the chronic irritation of eruptions about the face or head, running ears, or scabs and sores on the head. In some cases a row of hard enlarged glands behind the ear towards the back of the neck is the first indication of sores on the head to which no attention has been paid. Lymphatic glands may, however, become inflamed from other causes than these. Injury may be the cause. Again, the glands may inflame in the course of other diseases, such as measles, scarlet fever, &c.; while affections of the lymphatic glands are the troublesome occurrences in scrofula (king's evil), and such constitutional diseases.

Symptoms.—The disease occurs in an *acute* and a *chronic* form, and the symptoms vary accordingly.

In the *acute* attack there is some fever, preceded by shivering, the gland becomes swollen, hard, hot, and painful, and the surrounding parts usually also become swollen and tender. If matter forms, the hardness yields, and the gland gives to the fingers a peculiar feeling that indicates fluid matter within it.

In the *chronic* variety the pain and heat are less, perhaps absent, the surrounding parts are unaffected, and the noticeable feature is the presence of the hard, enlarged gland (kernel) freely movable under the skin.

Treatment.—It ought to be perfectly clear that the first thing to be done is to discover, as exactly as possible, what is the cause of the inflamed gland. It is of the utmost consequence to find out if the inflammation is due to irritating matter being carried to it from some neighbouring part. Because if this is the cause it is useless to treat the gland so long as the irritation is not removed. The probability is that if the supply of the substance producing the mischief is cut off, the gland will begin at once to recover itself. It becomes, therefore, a very important thing to notice from what parts of the body certain lymphatic glands, which are most commonly affected, receive their supplies by lymphatic vessels, so that when any of these glands is affected, the whole district of the body in connection with it may be scrutinized to find if any source of irritation be pre-

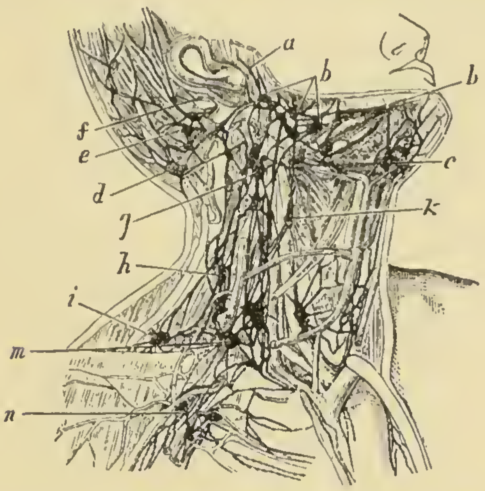


Fig. 128.—Lymphatic Glands of Head and Neck.

Glands in front of and below the ear, *a*, *b*; under the jaw, *b'*; under the chin, *c*; behind the ear, *e*, *f*; at the back of the head, *d*; in the neck and above the collar-bone, *g*, *h*, *i*, *k*, *m*; on the chest, *n*. The dark lines are communicating lymphatic vessels.

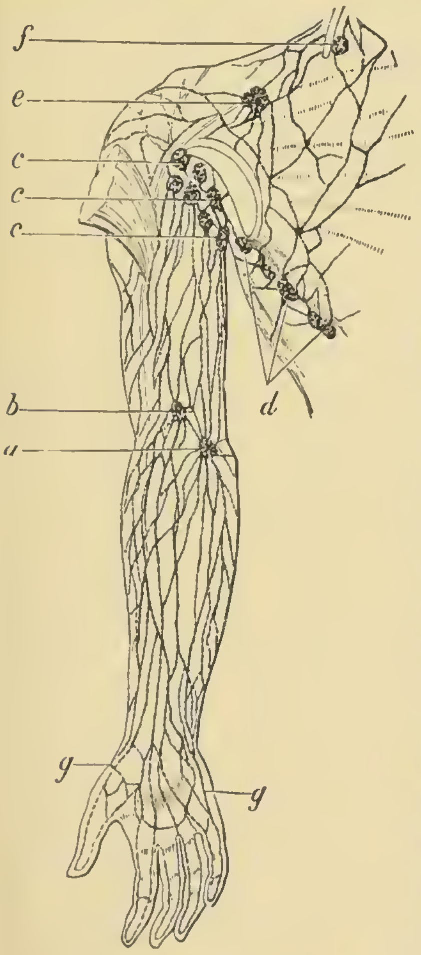


Fig. 129.—Lymphatics of the Arm and Arm-pit.

Glands at the inner side of the elbow, *a*, *b*; in the arm-pit, *c*, *c*, *c*; on the chest in front of the arm-pit, *d*; above the collar-bone and communicating with the arm-pit, *e*, *f*. *g*, *g* point to lymphatic vessels forming an arch round the hand. The dark lines are lymphatic vessels.

sent. To aid in this search the following woodcuts have been introduced. Fig. 128 shows the glands of the head and neck. [Distinction must be made between the lymphatic glands of this region and the salivary glands, which have been described on p. 197, and their positions indicated in Fig. 103, inflammation of which is called **mumps** (p. 213).] The glands in the immediate neighbourhood of the ear and those at the back of the head are to be noticed, as well as those under the chin and the chain of glands passing down the neck. This chain communicates with those of the arm-pit (Fig. 129), so that a diseased condition of the former may be passed down to the arm-pit. Now if glands near the ear be affected, examine the ear and parts in front for the cause; if those at the back of the head, carefully investigate the state of the head up to the crown for scabs, sores, &c. Eruptions on the head are almost certain to be attended by swelling of these glands. If those under the chin are inflamed, examine the mouth, the condition of the teeth, and so on. Attention to a discharging ear, cleaning sores on the head, removing scabs by warm applications, bathing with warm water, treating any skin eruption that may be present, removal of decayed teeth, &c., may be quite sufficient to arrest the affection of the gland and promote its recovery. Fig. 129 shows the lymphatic vessels and glands of the arm and arm-pit. Note that the lymphatic vessels of the hand and arm pass to glands at the back fold of the arm-pit, while the fold towards the chest has a row of glands connected with the chest. If any of the former is affected, see that any bad condition of the arm, hand, or fingers is attended to. An irritable finger-nail may be the whole cause of the trouble. In Fig. 130 are exhibited the glands of the groin. There is a double row of them, one in the line of the groin, the other below them in the upper part of the thigh. The latter receive lymphatic vessels from the leg and foot. An irritable toe-nail may irritate them. The former are connected with the private parts, the genital organs, and the region of the anus. Hacks or sores about these parts readily cause enlargement and inflammation of the glands of the groin.

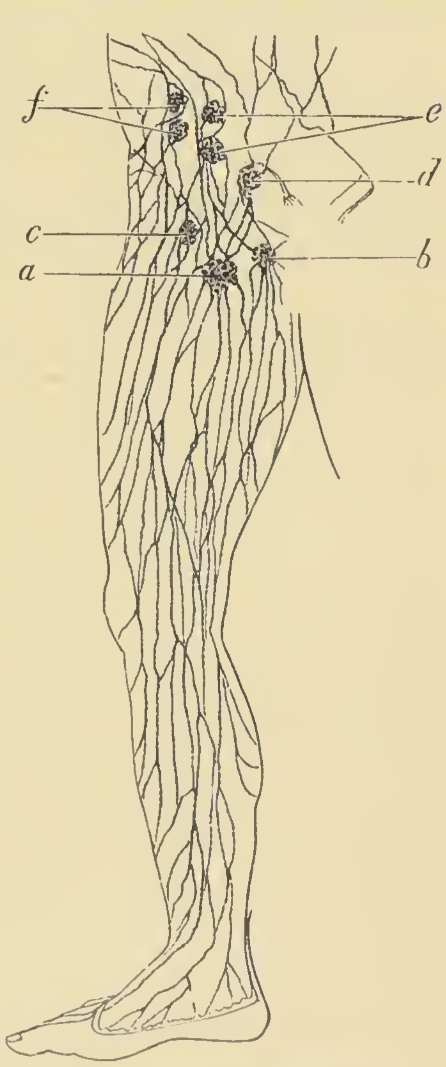


Fig. 130.—Lymphatic Vessels of Leg and Groin, and Glands of the Groin.

Chain of glands above the groin, *d*, *e*, *f*; below the groin in front of the thigh, *a*, *b*, *c*. The dark lines are the lymphatic vessels.

This is the first part of the treatment—*remove any source of irritation to the gland.* If the disease be but beginning, do nothing else; in particular, *do not rub the gland, otherwise it* *may be worried into producing matter*; only let the part be kept *moderately* warm and protected from all rough usage by rubbing, fingering, or otherwise. Should the inflammation develop, still do not rub, nor apply any stimulating liniments to the part. That can only increase the inflammation. Soothing applications must be the rule. For this purpose apply cloths wrung out of warm water. Give the patient a dose of castor-oil, seidlitz, or citrated magnesia (effervescing), so as to open the bowels freely. Light nourishing diet, particularly milk food, is proper. The inflammation may lessen and promise to pass off without matter being formed. Aid this result by keeping the person quiet, by applying the warm cloths occasionally, and by putting on a light flannel cloth between the times of using the warm applications, and by still an occasional dose of medicine. Often, however, matter is produced, and an abscess formed in the gland. *This must be opened by a surgeon to let the matter out.* Let no mistake be made about this. Very many people strongly object to an abscess about the face or neck being opened by a surgeon. They prefer to let it burst. They seem to imagine that, if opened with a surgeon's lancet, it will take longer to heal or leave a worse mark than if it is poulticed and allowed to open by its own processes. It would be difficult to discover any reason for this idea, which, it ought to be said plainly, is utterly false and absurd. Suppose it is necessary to make an opening in a sheet of glass, nobody would be mad enough to imagine that the safest way was to dash his fist through it, or to throw a stone through it, or to break the hole in it by a strong pressure against it from one side. Everyone would at once say, let a glazier be got, and let him cut the piece out with a diamond. In that way a clean cut would be made, while in any other way there would be the certainty of a star-shaped or ragged hole, and the risk of destruction of the glass. Now it is precisely the same with the collection of matter in the gland. It must be got out. If it is left to burst, the matter goes on collecting; it cannot at once break through healthy skin. More and more collects until the skin is stretched, and itself becomes more or less inflamed with the pressure on it from within. By and by the skin becomes undermined and thinned, and at last, when it has become so injured by the pressure and inflammatory process, and so softened that it cannot hold against the pressure any longer, it gives way, and, instead of a clean opening, a ragged, irregular tear is produced. Matter comes oozing away for a considerable time, and at last, when it heals, an ugly livid scar is left to mark the place. If, however, as soon as matter forms, a clean cut is made through the still healthy skin, the matter thoroughly cleaned out, and the wound properly closed, no further trouble should arise, and a fine line, which might be a wrinkle in the skin, should alone remain, a scarcely noticeable sign of what has been done. It is quite true that doctors often open such abscesses without getting them to heal quickly. From the wound matter proceeds for days and weeks, and finally a bad mark is left. The parents or friends of the child complain loudly, blame the doctor, and on the basis of their small experience assert the abscess ought never to have been opened. But in the majority of cases the reason is that the doctor has not been consulted early enough. The parents or guardians have tried their own hand first, and usually only after delay, and after the part has been worried by the attempts made to set it right, is the case brought to a surgeon. If the inflamed gland is to be treated with success it must be properly treated from the first; and if an abscess is to leave no mark, the matter must be afforded a way of escape as soon as it has formed. Besides, if a surgeon be consulted early enough, he may be able, having made a clean cut through the skin, to dissect out the gland entire without opening into it, an unopened sac or bag of matter. If so, no matter escapes to infect the wound, which can then be quite closed by fine stitches, and in time this leaves no mark beyond a fine line resembling a crease in the skin.

The treatment for chronic cases consists in treating the scrofular or other constitutional condition which maintains the gland affection. The treatment is mainly good nourishing food, sea-bathing if possible, and the use of cod-liver oil, chemical food, or syrup of the iodide of iron, of which half a tea-spoonful is an ordinary dose. In such cases applications to the gland itself are not desirable. Often, however, the gland is quite destroyed and its place occupied by masses of cheesy matter, or unhealthy-looking ulcers are the result of the disease. All such unhealthy material should be scraped away by a surgeon.

LYMPHATIC TUMOURS.

The lymphatic glands are liable to increase of size from excessive growth of the adenoid tissue of which they are composed (see p. 277).

This occurs in **Leucocythæmia** (see p. 315). **Lymphoma and lymphadenoma** (*Hodgkin's Disease*) are terms applied to some forms of lymphatic tumours. They cannot be considered in such a work as this. It is, however, of importance to notice that cancer speedily affects the lymphatic glands, and thus a cancerous tumour, which is at first a local disease, that is, affects only the place in which it is situated, spreads by particles of it being carried by lymphatic vessels to glands in the neighbourhood. From the glands it spreads onwards till the local disease becomes a constitutional affection. Now this is of the utmost consequence to notice, because while the disease is still local it may be curable, only, however, if the tumour be completely removed by a surgeon. If, however, the diseased part has not been cut out, but has been allowed to extend so as to infect the glands, the time most favourable for operation is past. Therefore the earliest possible operation for the removal of a cancerous tumour is necessary, and no consideration should be permitted to encourage delay as soon as a qualified surgeon has given his opinion that the disease is cancer and should be removed. Of course it becomes evident that a case of cancer in some of the abdominal organs cannot thus be interfered with, and so the disease rapidly spreads among the glands of the bowel.

Abscess of Glands. See p. 286.

DISEASES CONNECTED WITH THE SPLEEN.

The spleen is undoubtedly affected by diseases common to other organs, such as congestion, overgrowth, tumours, &c. &c. But the symptoms of such affections are too vague and the results too uncertain to be dwelt on here.

Enlargement of the Spleen is a common feature in cases of ague, which is discussed among FEVERS, and in the disease called leucocythæmia, referred to under DISEASES OF THE CIRCULATORY SYSTEM, p. 315.

DISEASES CONNECTED WITH THE THYROID GLAND.

Goitre (*Bronchocele, Derbyshire Neck*) is the chief disease of the thyroid gland (p. 281). It consists of an enlargment of the gland, sometimes a uniform enlargment of all its substance, sometimes an excessive growth of some part of its ordinary structure. The amount of enlargement varies from a mere extra fulness in the front of the neck to an enormous growth hanging down over the chest. It is commoner in females than in males, and occurs rather between the ages of eight and twenty. It is a disease which may be found anywhere, but is endemic, that is, common among the people living in a certain district. Thus in England it is common in Derbyshire, and is hence called **Derbyshire neck.** In Yorkshire, Hampshire, Sussex, and Nottinghamshire, in the Swiss valleys, among the Alps, Himalayas, Andes, and in the Green Mountain region of Vermont in America it is also common. Its frequent occurrence in such districts is ascribed to some malarious tendency, and specially to the nature of the drinking water. An excess of lime salts in the water, particularly carbonate of lime, is held to be the chief cause of its production. People coming into a goitrous district, who stay in it for a sufficient length of time, are liable to be affected, while children of people who have the disease, and who are removed from the place, cease to be liable. The disease is not, therefore, hereditary, but peculiar to the locality.

Its **symptoms** are those of a tumour situated in the lower part of the front of the neck, in front of the windpipe. The tumour goes on enlarging, usually without pain. Any other symptoms are such as would naturally result from the presence in that region of a tumour of any size, symptoms due to pressure. The pressure on the windpipe may obstruct the passage of air by compressing the tube. The gullet behind may be compressed. Veins may be pressed upon, and nerves. The danger of compressing nerves is specially great, since the nerves proceeding to the windpipe are liable to be involved, and the irritation produced may lead to spasmodic closure of the windpipe and sudden suffocation, or suffocation may arise from gradual closure of the tube by the gradual compression. Even when the tumour is of moderate size, headaches, some difficulty of breathing, and tendency to congestion in the head are signs of the pressure produced by it.

Treatment.—The first thing to be done is to have the patient removed, if possible, from the goitrous district to the sea-coast. If this be impossible, at least efforts may be made to diminish the tendency to goitre by purifying the drinking water, which seems to be the chief agent in the disease. If it contain excess of carbonate of lime, this may be got rid of by boiling the water. Carbonic acid is driven off, and the lime in combination with it falls to the bottom, so that the clear water may be decanted off. Shaking it up with air will render it palatable for drinking. Clark's process for ridding water of excess of carbonate of lime consists in adding lime to the water. This unites with the excess of carbonic acid in the water to form carbonate of lime, which falls to the bottom along with the carbonate previously held in solution in the water. The water may also be purified from salts by distillation. But this process removes all the salts from the water, and makes it very tasteless, which is not desirable.

As regards medicines for the treatment of goitre, the chief is iodine, given as iodide of potassium in doses of 2 to 20 grains according to age and the way in which it is tolerated by the patient. It should be given twice or thrice daily, simply dissolved in water. Along with it there may be conjoined the use of iodine liniment painted over the enlarged gland occasionally, but not often enough to irritate the skin.

The treatment by "burnt sponge" is the same as that by iodine. It seems to be the iodine in the "burnt sponge" that is the efficient ingredient.

In India an ointment of mercury is used. It is made by melting 1 pound of lard or mutton suet, which, when melted, is cleaned, strained, and then allowed to cool. When it is nearly cold, 180 grains of the biniodide of mercury, ground into a very fine powder, are mixed with it in a mortar till the red powder is uniformly distributed through the lard and no grains are visible. The ointment is kept in pots, protected from the light. It is used in the following away: At sunrise the ointment is applied to the swelling by means of an ivory spatula, and is well rubbed in for at least ten minutes. "The patient then sits with the goitre held up to the sun as long as he can endure it. In six or eight hours there will probably be some pain from the blistering action of the application." The application is repeated at about two in the afternoon, the ointment being lightly rubbed in this time, and is allowed to remain for several days. In ordinary cases one treatment of this kind is sufficient, but if necessary it may be repeated in six or twelve months. When a strong sun is not obtainable a very hot fire may act as its substitute, the patient sitting before it. The same ointment may be employed by rubbing it in, morning and evening, for several days.

It is not considered justifiable to have the tumour removed by an operation, and that for various reasons, among them because of the extensive blood supply to the gland, and the way in which this is increased in enlargement of the gland. Cysts, abscesses, &c., that may form in the gland are opened, often with great relief to the patient.

Exophthalmic Goitre (*Graves' Disease, Basedow's Disease*) is a disease in which enlargement of the thyroid gland, great prominence of the eyeballs (*exophthalmos*, from Greek *ex*, out, and *ophthalmos*, the eye), palpitation of the heart, and a fine general tremor over the body are the special features. The disturbance of the heart and the protrusion of the eyeballs may, however, exist without the thyroid enlargement, though the symptoms are due to excessive activity of the gland—**hyperthyroidism.** It occurs usually in young women after puberty, and commonly in pale, nervous subjects. Indeed, some believe the disease is at first due to some bad condition of the sympathetic nervous system (see p. 152). The symptoms sometimes develop suddenly after a fright or profound emotional disturbance.

The **symptoms** are chiefly those already mentioned connected with the heart, the eyes, and the thyroid gland. Other symptoms are common—disturbances of the digestive system, irritability of temper, feverishness, sleeplessness, and irregularity of the monthly periods. The person's eyes are easily fatigued, and motes are seen passing before the sight.

The disease is essentially a chronic one, lasting for many years.

The **treatment** need only be indicated, for it should be under careful medical direction. It is certain that, if at the very outset systematic treatment is undertaken, a much greater hope of recovery exists than if the patient struggles on for a long time, trying merely the effect of drugs.

If the patient were taken to a nursing institution at the outset, put to bed, shut off from everything and everyone, having no letters, writing none, seeing no visitors, being nursed carefully, and being permitted such reading and occupation as will interest without exciting, there is a much better chance of rapid improvement than is likely to occur at her own home. She should, of course, be under medical care, and in such an institution there is the opportunity of trying the various drugs that have been advocated in this disease, and of pushing them as far as possible. Such drugs are arsenic and iron, belladonna, phosphate of soda; extract of thymus gland has also been used with benefit. Electrical treatment has been found very useful, the constant current applied to the neck; and the author has seen excellent results from the Nauheim treatment. In many cases by an operation on the enlarged gland a cure can be effected, and X-ray treatment is equally effective in suitable cases.

Myxoedema is a disease associated with degeneration of the thyroid gland. It is much more frequent in women than in men, and more usual in elderly women, at least the commonest age is about forty years. Cretinism may be regarded as an infantile form.

Its development is slow and insidious, so that it is often already of considerable duration before it is recognized.

Symptoms.—The chief symptom is due to an alteration of the character of the skin and connective tissue under it, by which a kind of dropsy is produced. This dropsical condition, however, differs from ordinary dropsy in that it does not "pit" on pressure; it is a solid swelling, not a watery one. It affects the whole body; the face becomes puffy, swollen, coarse; the eyelids are baggy, and the upper lids droop over the eyes, the forehead being wrinkled in the effort to keep them raised; the lips are large and coarse; the nose is broadened; the ears large and swollen. The patient notices that gradually she requires larger gloves and larger boots and wider clothing. The podginess of the hands interferes with some kinds of work, sewing for instance, and the touch for the piano or violin is lost. The skin has a dirty-yellowish hue, but below the eyes there is a peculiar waxy, translucent appearance and often a high colour of the cheeks. The hair is dry, brittle, and scanty, and the scalp may be covered with dirty-yellowish or brown patches. The patient may be compelled to wear a wig. The voice is muffled, and the person speaks as if her tongue were too large for her mouth, or as if she had not control of her lips, and the speech is slow. The skin is dry and wanting in sweat, and easily affected by cold. There is a feeling of weakness and lassitude, and a degree of mental sluggishness. The heart's action is feeble, and the circulation weak, but the kidneys are not affected.

The changes which have been noted produce a striking facial appearance, not to be mistaken when the disease is advanced. This is well seen in Plate II. The disease lasts for many years, and death usually is due to the occurrence of some low type of bronchitis, pneumonia, or influenza.

Treatment is now very successfully conducted by the use of fresh thyroid glands, or thyroid extract or tabloids, but should be under medical supervision. Plate II. shows the remarkable change such treatment may produce in a short time in all the symptoms.

Cretinism is a form of idiocy associated with a peculiar condition of the body. It is mentioned here because it is associated with goitre, and seems to be due to the same cause. Cretins are usually affected with goitre, and are numerous in districts where goitre prevails. Moreover, cretinous children are usually the offspring of goitrous parents. Cretins are ill-grown and stunted, with swollen bellies. The skin is coarse, head large, flat at the top and expanded at the side, the nose sunken and flattened at the bridge, the lips thick, chin protruding, mouth wide and gaping, the tongue large. The countenance is dull and heavy; there is general muscular weakness and slowness of sensibility. Associated with these are feebleness or want of intellect, and sometimes deafness and dumbness, perhaps squinting and blindness.

Treatment of cretins is more moral than anything else. Careful training may do much for them, along with good food, cleanliness, exercise, &c. The disease does not appear to be hereditary, and goitrous people who have removed from the tainted district do not beget cretinous children. It also appears that cretins who have removed from the district where goitre prevails, and live in a healthy place, may beget children free from both goitre and cretinism.

Cretins are liable occasionally to violent outbursts of temper, which, however, proper training and moral control can do much to prevent. As a rule, however, they are quiet and harmless. An establishment for the care of cretins has been founded at Abendberg, near Interlaken, in Switzerland, by Dr. Guggenbühl.

Treatment by thyroid feeding has frequently yielded remarkable results. It must be directed by a physician.

Acromegaly is another disease associated with a blood gland, and first fully identified by a French physician, Marie, in 1885. It seems related to the pituitary gland, as myxoedema is to the thyroid, being associated with changes in that gland due to disease.

The chief **symptoms** are great enlargement of the hands and feet, hence the name applied to the disease, which means large extremities. The bones as well as the soft parts are enlarged, and the soft enlargement is not dropsical, for it does not pit on pressure. The hands become spade-shaped. The face also is altered, becoming lengthened, the lower jaw being markedly enlarged and projecting, the nose thickened and flattened, the eyes widely separated. The tongue becomes almost too large for the mouth, and the voice is harsh. The bones of the trunk also are increased in size, specially the upper of the vertebræ of the chest, so that the upper part of the back becomes rounded and the head thrust forwards and downwards. The patient suffers from muscular weakness and headache, the latter being probably due to pressure of the enlarged pituitary body on the brain, and there is a defect of sight due to the same cause. The disease is a very rare one. In women it often begins about the age of puberty, and usually there is absence of the monthly flow. This may first attract attention. It is slow in its progress, lasting ten or twenty years or more.

Treatment is not satisfactory, though pituitary feeding should get a prolonged trial, as well as iron, arsenic, and other tonics. An X-ray photograph of the head should be taken.

DISEASE CONNECTED WITH THE SUPRA-RENAL CAPSULES.

Addison's Disease is the only disease connected with the capsules above the kidney that need be noticed here. It receives its name because it was first described by Dr. Thomas Addison, a physician of London.

The chief **symptoms** are gradual on-coming of extreme weakness and a peculiar discoloration of the skin. The person becomes less and less disposed to bodily exertion, and the least effort brings on shortness of breath and palpitation; and, in advanced cases, sudden attacks of faintness are the result of even trifling exertion. Various other symptoms accompany these —loss of appetite, sickness and vomiting, dimness of sight, headache, chilliness, &c. The discoloration of the skin is in the form of a bronzing, beginning as a darkening of the skin, first in the face, neck, and hands, and then in the lower parts of the body, the hue gradually deepening till the dark colour is attained. The bronzing is due to the deposition of colouring matter in the cuticle or scarf-skin. These symptoms are associated with alteration of structure of the supra-renal capsules. Since Dr. Addison published his discoveries, however, cases of disease of the capsules have been met with in which there was no discoloration of the skin.

Death usually results from weakness, and occurs commonly within a year, though the disease may continue for several years before it proves fatal.

Treatment is vain. All that can be done is to maintain the patient's strength, as much as possible, by wholesome food, tonics, and perhaps stimulants. The person should also be kept at rest, since fatal prostration may result from slight exertion. Treatment on the same lines as that for consumption, carried on in a sanatorium, would be the most likely way to relieve the patient.

SECTION XIV.

THE BLOOD, THE HEART, AND BLOOD-VESSELS.

(THE BLOOD-VASCULAR SYSTEM).

STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Blood:
- *Its Structure and Microscopical Appearance*—Plasma—Red and White Corpuscles;
- *Its Coagulation*—Fibrinogen and Fibrin;
- *Its Chemical Composition*—Hæmoglobin—Gases;
- *Its Functions.*

The Apparatus of the Circulation:
- *The Heart*—Its Shape and Size—The Pericardium—Its Chambers and Valves—Blood-vessels connected with it—Its Action and Nervous Control;
- *The Blood-vessels*—Structure of Capillaries, Arteries, and Veins;
- *The Distribution of the Blood-vessels.*

The Circulation of the Blood:
- *The Circulation in the Body generally and in the Lungs*—The Portal Circulation;
- *The Circulation in the Arteries*—The Pulse;
- *The Circulation in the Capillaries*—Vascular and non-vascular tissues;
- *The Circulation in the Veins*—Summary of the forces that carry on the circulation;
- *The Rapidity of the Circulation;*
- *Nervous Control of the Circulation*—Vasomotor Nerves—the Production of Blushing and Pallor.

THE BLOOD.

(Refer to Plate III.)

This work is, of course, designed more for consultation than for systematic reading. Nevertheless it has been considered advisable to take up one part of the body after another in a regular order, so that, if any one chooses to read the sections on Anatomy and Physiology in the order in which they are given, a general and connected account of the whole body in its structure and workings will be obtained. It is of value for the understanding of the subject of this section to consider, for a moment, what stage has been reached in the regular study of the body. In Section X. we discussed the process of digestion, and perceived that the whole end and aim of that process was to prepare material fit to enter the blood and maintain its quality and quantity. The consideration of the lymphatics and blood glands, in Section XII., showed that the blood received supplies from lymphatic vessels of lymph prepared by lymphatic glands, and had also additions made to it by the blood glands, notably the spleen. We thus perceive that the blood, which is being continually drained by the demands made on it by the whole body for its nourishing material, has two main sources of supply, namely, first and chiefly, the food, and secondly, the lymphatics and blood glands. We shall see in Section XVI. that this does not exhaust the sources whence the blood draws supplies, and that the lungs are the channel by which a substance is conveyed to the blood, not second in importance to what is received by the alimentary canal, the substance oxygen gas, namely.

Such being the sources of the blood, our next question is as to its nature.

Microscopical Characters of Blood.—The microscope reveals much as to the nature of the blood. Blood is prepared for examination by the microscope in a very simple way. The twisted corner of a handkerchief is wound tightly round the end joint of a finger. This obstructs the flow of blood, and the point of the finger becomes purple and congested. A smart dab with a clean needle draws a drop of blood at once. A small quantity is got on the centre of a slide, such as is used for microscopic purposes, by making the slide touch the drop, and it is immediately covered with a very thin circle of glass (a cover glass). The slide is then put on the stage of a microscope and examined. Under a moderately high magnifying power the appearance represented in Fig. 131 is seen. The blood is evidently not altogether fluid. It contains small bodies in great numbers, which are floating in a liquid. Contrary to what would be expected, the liquid is of a light straw colour, indeed almost colourless. The small bodies, however, are coloured. They appear red when seen in layers, but singly they are yellow. The fluid is called **plasma**, or **liquor sanguinis** (liquid of the blood); the small bodies are the **red corpuscles** (small body, Latin *corpus*, a body) or cells of the blood. If the preparation be quickly examined, or if the cover glass be gently disturbed with a needle, the corpuscles will be seen separate from one another, but they quickly run together to form rows or rouleaux, like piles of coin, as represented in the figure. This is owing to their shape. If one be carefully examined as it lies on its edge, it presents the appearance shown at *a* in Fig. 131, thinner at the middle than at either end. If one be seen lying on its face its appearance is as represented by *b* of the same figure. It is circular, and the centre is dark, while the edge is clear. If the focus of the microscope be altered, the centre becomes clear and the edge dark. In other words the two surfaces of the corpuscle are not flat, they are hollowed towards the centre, so that the corpuscle is thinner at the centre than at the margins. The body is thus hollowed on each surface, is, in a word, a biconcave disc. On a casual glance the red corpuscles are the only bodies seen in the fluid, but, on looking carefully, other bodies slightly larger and few in number are perceived. They are seen here and there in the spaces formed by the rows of red cells. They keep separate from one another, are white, and contain little dark granules in their interior. They are the **white or colourless corpuscles** of the blood, and are also termed **leucocytes** (Greek *leukos*, white, and *kŭtos*, a cell). They are represented in Fig. 131, *c*. There are usually not more than three or four seen in the field. There is in healthy human blood, on an average, 1 white blood corpuscle for every 600 to 1200 red ones. They are irregularly globular in shape.

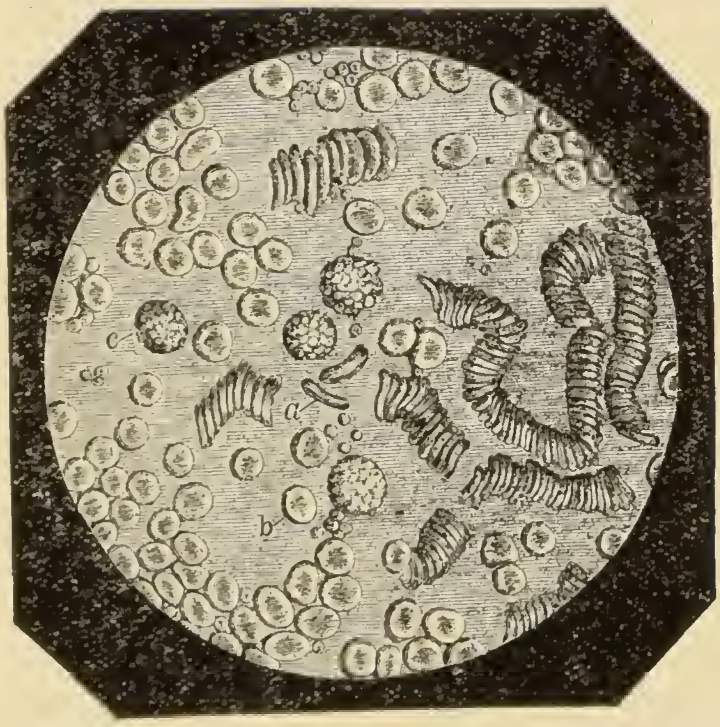


Fig. 131.—A Drop of Blood, seen under a Microscope magnifying by 350 diameters.

Much can be learned about these blood cells by simple means. On the addition of water to the drop of blood, the red corpuscles swell up, lose their biconcave shape, and become round. They also become paler, while the fluid in which they float becomes yellowish. The meaning of this change is that the water has entered into the corpuscle, swelling it up, and has dissolved some of its colouring matter, which passes out and stains the plasma. The addition of a strong solution of sugar or salt causes them to shrink and become shrivelled looking, because the fluid parts of the cell have passed out to dilute the plasma, rendered more dense by the addition of the salt solution. The action of acetic acid causes the red blood corpuscle to disappear. It becomes paler and paler, and finally becomes invisible, or at least but the faintest shadowy indication of it is left, if the action of the acetic acid is not pushed. No trace of it may be left. On white blood corpuscles the action is similar, the cell becomes more and more transparent, till the bulk of the granular protoplasm of which it is composed disappears. Something else is, however, brought into view, namely, small bodies—**nuclei**—contained in the cell, but not easily seen, because obscured by the protoplasm, till the clearing up of the cell reveals them. A small white blood corpuscle may contain only one nucleus, the larger ones contain several. Thus, besides the differences already noticed, the red and white corpuscles of human blood differ in this, that the latter are nucleated while the former contain no nucleus.

Almost all vertebrate animals (animals having a backbone) have the kinds of blood cells described, but they are not all of the same appearance as in human blood. In mammals (animals that suckle their young) the red cells are disc-shaped and without a nucleus, except in the camel, where they are oval though without a nucleus. In all other vertebrate animals they are oval and have a nucleus. In man and in all mammals, with the exception of the camel tribe, the red corpuscles are biconcave as already described; but in birds, reptiles, and fishes they are biconvex, thicker in the middle than at the edges. They differ in size also in various animals.

When carefully measured, human red blood corpuscles are found to be about the $\frac{1}{3200}$ of an inch across. [The white corpuscles are larger, being about the $\frac{1}{2500}$ of an inch in diameter.] In the elephant they are $\frac{1}{2745}$ of an inch; in the musk-deer they are very small—$\frac{1}{12325}$. In the proteus, a remarkable amphibian (an amphibian is an animal which may breathe both by gills and by lungs)—in the proteus there are the largest red corpuscles found in any vertebrate animal—$\frac{1}{400}$ of an inch. In Fig. 132 are shown corpuscles of various animals magnified by the same amount.

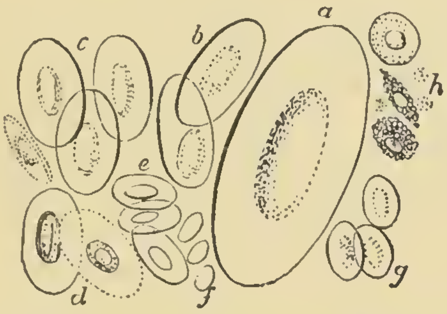


Fig. 132.—Blood Corpuscles of various Animals magnified in the same scale.

a, From proteus (an amphibian); *b*, salamander (amphibian); *c*, frog; *d*, frog's corpuscle after addition of weak acetic acid, showing nucleus; *e*, bird; *f*, camel, oval, but not nucleated; *g*, fish; *h*, crab or other invertebrate animal.

A remarkable thing about the colourless blood corpuscles is their power of altering their shape. The red corpuscle can have its shape altered, but only by pressure from without. The pressure of one on the other changes the shape, and on removal of the pressure the old shape returns. If a red corpuscle is passing through a narrow channel it lengthens and becomes narrow till it has passed through, when its shape is restored. But the white corpuscle is active in its change. It is constantly changing, but so slowly as to be with difficulty noticed in an ordinary preparation of a drop of blood. The change of shape is effected by what are called *amœboid* movements, which have been sufficiently described on p. 53. The corpuscle can push out and draw in portions of its body, which is now globular and now elongated. By such changes of form the cell may wander from place to place. It has been shown, for instance, how the white corpuscles may wander out of the blood-vessels in the living body, pushing their way through the living walls and insinuating themselves amongst the tissues outside the vessels. The cells have been called, in consequence, **wander cells**. Moreover, the cells that form the matter of an abscess are not distinguishable from certain kinds of the white cells of the blood, and it is not certain whether they are not cells which have passed out of the blood-vessels in the process of inflammation. (See p. 328.) Again, the white cells found in lymph after it has passed through a lymphatic gland, found also in such numbers in lymphatic glands and in the spleen, are identical with those of the blood.

The number of white cells increases in the blood after meals and quickly diminishes again. Thus a German observer estimated the proportion of white cells to red before breakfast as 1 to 1800, an hour after breakfast as 1 to 700, and some hours later as 1 to 1500.

When a more minute examination of the blood is desired the method described in the Introduction (p. 18) is followed, by which varieties of red cells are detected and also of white. That portion of the Introduction should be read here, and the plates there introduced studied. By methods, which need not further be referred to, the number of red cells may be counted, as well as the number of each variety of white, and the amount of colouring matter each red cell contains may be estimated.

The Quantity of Blood in the body has been estimated in various ways, though, of course, the quantity cannot be stated with absolute accuracy. It is supposed in an adult man to be about one-thirteenth of the total weight of the body, that is about twelve pounds by weight in a person of eleven stones. When the multitude of corpuscles in a single drop of blood is considered, it will be evident that the total number of corpuscles in the blood of the body is scarcely countable, and certainly quite inconceivable. They have been counted, however, and the estimate is that in the $\frac{1}{625}$ of a cubic inch of blood there are a little over five millions of corpuscles. It has also been estimated that if all the red blood corpuscles in the blood of an adult man could be laid down side by side, they would cover an area of 3000 square yards.

In the disease called **anæmia** the number of red corpuscles is greatly diminished.

Plethora is the term applied to the opposite condition, in which the number is greatly in excess of the usual standard.

Coagulation of the Blood.—If blood be drawn from an animal into a vessel surrounded by a freezing-mixture it remains liquid. The corpuscles, being heavier than the fluid in which they float, fall to the bottom, and thus the blood is separated into the corpuscles at the bottom of the vessel, and the plasma or liquor sanguinis above. If the blood were kept in the fluid state for a sufficient time the difference in the layers of plasma and corpuscles would be marked by the great difference in colour, the plasma being almost colourless, and the layer of corpuscles of a deep red. If, then, the cold were withdrawn the blood would speedily cease to be fluid, and would become a coagulated or clotted mass, the solidified plasma having the appearance of a clear jelly with a yellowish tinge. The cause of the clotting is easily seen if one takes a drop of blood on a slide, and waits for a minute or two before putting on a cover glass and examining it. In two or three minutes the drop of blood on the slide forms a clot. On covering it with a covering glass, and examining with the microscope, fine glassy fibres are seen forming an irregular net-work, in the meshes of which lie the corpuscles. It is the formation of these fibres that has caused the setting of the drop of blood. The substance thus formed from blood, after it is withdrawn from the vessels, is called **fibrin**. It consists of white structureless filaments or threads. It does not seem to exist in the blood as fibrin, as we shall see, but is formed after the blood is drawn, or after contact of the blood with foreign bodies. Fibrin is formed very quickly in blood removed from the blood-vessels, but its formation may be delayed by cold, as we have already seen, or by the addition to the blood of certain salts, common salt, for example. Fibrin may be separated from blood, before coagulation takes place, by whipping the blood with twigs. The fibrin forms on the twigs, from which it can be washed off, when it appears as a white stringy substance. The blood left behind will no longer coagulate, because the fibrin has been removed.

Suppose now that blood be drawn into a tall glass vessel, no precautions as to the maintenance of a low temperature being taken, in from five to ten minutes coagulation takes place throughout, and a sort of firm red jelly is formed. The corpuscles, not having time to sink to the bottom, are entangled in the meshes of the fibrin, and the whole mass is red in colour. The clot takes the shape of the vessel in which it is contained. If a little delay has taken place in coagulation the corpuscles have sunk to some extent, and the clot will have a deeper colour towards the deeper parts, the bottom layer being deepest of all. The white blood corpuscles are, however, lighter than the red. They do not sink so fast, and are, therefore, entangled towards the surface of the clot, giving it a whitish or creamy look on the top. This used to be called the **buffy coat**. Where the coagulation has been very quick, the separation has no time to be effected, and the buffy coat is absent. If the clot be left alone in the glass vessel, by and by other changes take place. The fibrin, whose formation has caused the coagulation, begins to shrink. As the clot is attached to the sides of the vessel the shrinking is more pronounced towards the centre, and thus the surface of the clot gets hollowed or **cupped**, as it is called. The shrinking of the clot squeezes out a clear yellowish fluid, which soon separates the clot from the sides of the vessel, and thus we have the clot floating in a fluid of a straw-yellow colour. This straw-yellow fluid is **serum**. Now let us distinguish between serum and plasma. In blood as drawn from an animal we have corpuscles, and plasma or liquor sanguinis. By coagulation the plasma is separated into fibrin and a fluid—the serum. Thus blood, less its corpuscles, is plasma or liquor sanguinis; and plasma, less its fibrin, is serum. This difference may be represented in the following way:—

Circulating Blood consists of—		Coagulated Blood consists of—
Liquor Sanguinis or Plasma	= { Serum Fibrin	Serum
Corpuscles (red and white)		Clot

It was formerly supposed that the fluid part of the blood held fibrin in solution, and that, when coagulation took place, the fibrin was precipitated or became solid, as in well-known chemical reactions, or that it became solid in consequence of something escaping from the blood, which held it in solution. The view now held is that fibrin does not exist as such in the blood, but that a substance called **fibrinogen** exists, from which fibrin is formed by the action of a ferment in the presence of lime salts. Why the changes do not readily occur in the blood in the vessels of a living animal has not yet been satisfactorily determined. In certain diseased conditions, however, they do occur. Thus foreign bodies introduced into the current of the circulation—a thread drawn through a blood-vessel and left there, for example—soon become covered with a layer of fibrin. It is well known, also, that a deposit of fibrin may readily occur on a part of the surface of a blood-vessel, or of the valves of the heart, that has been roughened by inflammation. When a clot is thus formed, either in the heart or vessels, it is called a **thrombus**. The risk of such an occurrence is great, and it is specially so when the deposit is on the edges of one of the valves of the heart, for a part of the clot may be detached and whirled away in the current of blood till a vessel is reached too small to give it passage. The clot blocks the vessel, and thus the area which it supplied with blood is either permanently or temporarily deprived of its supply. In such a case the clot is called an **embolus**, and the occurrence **embolism**.

It is by the formation of a clot that bleeding from a vessel that has been opened is stopped naturally. The clot closes the opening, and gradually fibrous tissue becomes formed at that part of the vessel, which thus becomes permanently closed. When a wounded artery is tied the same thing happens. A clot forms at the tied part, and finally fibrous tissue takes its place and the vessel is completely sealed up.

The Chemical Constitution of the Blood.—Human blood has an average specific gravity of 1055; it has an alkaline reaction, which in shed blood quickly diminishes up to the moment of clotting. We have seen that circulating blood consists of corpuscles (red and white) floating in plasma. Of the total weight of blood more than one-third, and less than one-half, is made up of the corpuscles, and the rest of the weight is made up of plasma. The plasma contains fibrin and serum, the fibrin forming about ·2 per cent, a remarkably small quantity considering the part it plays in coagulation.

The **red corpuscles** consist of 57 parts of water and 43 parts of solid matters in 100 parts of the wet corpuscles. The solid matter is mainly a substance called **hæmoglobin**, forming 90 per cent of the solids of the corpuscles, the remainder being proteid substances, traces of other organic substances (cholesterin and lecithin), and inorganic salts—the salts of potassium and phosphates. Hæmoglobin consists of an albuminous body, **globulin**, and a colouring matter, **hæmatin**, and it is capable of crystallizing in various shapes. It is remarkable for containing 4 parts of iron in 1000. Hæmoglobin forms a combination with oxygen gas called **oxy-hæmoglobin**, which is of a bright scarlet colour. But the oxygen may be removed from the hæmoglobin, which then becomes of a darker and more purple hue; or, if carbonic acid gas be substituted for the oxygen, a dark colour is produced. This is the essence of the explanation offered for the difference between the scarlet blood found flowing in arteries, and the more purplish blood of the veins. This is explained at greater length in Section XVI. If hæmoglobin, dark in hue because it has been deprived of oxygen, be exposed to an atmosphere containing that gas, it seizes upon it greedily, and speedily becomes of a bright hue. This is the reason why blood, which may have been dark when shed, becomes of a bright scarlet colour, at least on the surface, if exposed to the air. It seizes on the oxygen of the air. Thus the red blood corpuscles consist mainly of a substance greedy for oxygen, and thus these bodies become the oxygen carriers of the body, seizing upon the oxygen which they get in the air in the lungs, and hurrying with it to the remotest parts of the body. (See Section XVI.) Hæmoglobin, it may be added, is also called **hæmatoglobin or hæmatocrystallin**.

The **serum** of blood, that is, the plasma deprived of its fibrin, consists of water 90 per cent, albuminous or proteid substances 8 to 9 per cent, and 1 to 2 per cent of fats and saline matters, and substances capable of being dissolved out by water, alcohol, or ether, and hence called extractives, such as urea, kreatin, sugar, lactic acid. The saline matters are chiefly salts of sodium. Thus the serum differs from the corpuscles in which the potash salts are found.

The blood also contains *gases*, which may be separated from it by allowing the blood to flow into a vacuum at a temperature higher than body heat (98·4° Fahr.). At the ordinary pressure of the atmosphere, 30 inches of mercury, and a temperature of 32° Fahr., the quantity of gas separated from 100 volumes of blood is about 60 volumes. It consists of oxygen, carbonic acid, and nitrogen, in different proportions according to whether the blood was arterial or venous. Thus the 60 volumes are distributed as follows:—

	Of Oxygen	Of Carbonic Acid	Of Nitrogen
In arterial blood,...	20 volumes	39 volumes	1 to 2 volumes.
In venous blood,...	8 to 12 ,,	46 ,,	1 to 2 ,,

The significance of these figures will be commented on at greater length in the section in which breathing and its purposes are discussed (Section XVI.); but it is well to note now that arterial blood contains more oxygen and less carbonic acid gas than venous blood. With that fact we at once associate the bright scarlet hue of arterial blood, and the purplish colour of venous blood, remembering the love of the hæmoglobin of the red blood corpuscles for oxygen, and the bright colour resulting from its satisfaction, and the dark colour resulting from deprivation.

The Functions of the Blood are to carry nourishment to every tissue and organ of the body. It may be compared to a stream flowing through a tract of country, and giving off branches in all directions, so that it waters every quarter of the district. We know that that tract of country is likely to be extremely fertile, and we know what a change would come over it if the river were dried up; or, if one branch only were suddenly cut off, we know what a contrast the part formerly supplied by that branch would present to the rest, still watered as before. Now for the tract of country substitute the human body, and for the stream, with its many branches to every part of the country, substitute the blood carried in channels (the blood-vessels) to every portion of the body, and we have a very striking similarity. For the blood flowing through a part of the body as surely bathes the tissues beside which it flows as does a river water the fields along its banks. Thus the liver cells (p. 200) are situated in groups on the blood channels, which exist in such abundance in the liver. As the stream of blood flows past, they select from it what they need for their work, just as different trees and plants along the bank of a stream will suck up what nourishment they need. The liver cells select from the blood the substances out of which they may manufacture the bile salts, the bile colouring matters, &c. It is the same blood that flows through the brain, and here it comes in contact with brain cells, whose function, connected with thinking, feeling, willing, &c., is very different from that of the liver cells. Nevertheless from the same blood they find nourishment for their life and the source of their activities. They too select from it the substances they need, and convert them into that which it is their business to produce, and which is something very different from bile salts and colouring matters. It is the same blood that flows through a muscle and bathes the muscular fibres. They also find in it the elements that are necessary for restoring exhausted muscle fibres and building up new ones. It is the same blood that flows through the tissues of the eye and maintains in health and power this most wonderful of optical instruments. In short, just as in one garden you may have the lily and the rose near neighbours to strawberry beds and apple-trees, growing from the same earth and having the same rain and sunshine from heaven, yet each one selecting from the common nourishment the elements it needs, and converting them into flower and fruit very different from one another, so the blood in the human body contains nourishment for the liver cell and brain cell, muscular fibre and sentient organ, which each selects as its needs dictate.

While this is the main function of the blood, it serves that other purpose of carrying away, in its current, from the tissues substances, produced by their work, whose removal is necessary for the continuance of the healthy life of the part.

It is, then, quite clear how conditions of the blood specdily affect the whole body. Suppose the blood to be insufficient in quantity. Each tissue and organ gets a supply, but not enough. Its vigour is, therefore, diminished and its efficiency impaired. If the blood be equally distributed, all parts of the body may suffer equally and general symptoms of ill-health, not symptoms pointing out definitely one suffering part, are the result. In some cases one organ may suffer more than another, may get less than its own share of the diminished supply, and alongside of the general symptoms, which point out the general condition, are others indicating some organ on which the privation is specially hard. The blood may, however, be sufficient in quantity but bad in quality. Some particular element may be wanting. For example, scurvy is held to be due to absence from the food of some element, perhaps potash salts, perhaps citric acid, which fresh vegetables supply. Some substance may be present that ought not. For example, the liver may have failed to separate bile, and substances are left in the blood which, being carried through the body, act directly or indirectly as a poison. Some material may also gain entrance by the food, or air, or in other ways, which vitiates the quality of the blood and impairs its value as a nourishing fluid. How dependent, therefore, the whole body is on the quantity and quality of the blood is evident, and will become more clear when the results of its impaired efficiency are studied in the succeeding section.

PLATE XVI

THE TOPOGRAPHY OF THE HEART AND GREAT VESSELS OF THE CHEST

The General Description given on Plate XII applies equally to this, and should be read.

The broken black line marks the division between chest and abdomen, made by the **diaphragm (D.)**.

The heart is shown, its left side, red, its right side, blue.

L.A. is the left auricle, **L.V.** the left ventricle, **R.A.** is the right auricle, **R.V.** the right ventricle.

The great arterial trunk, issuing from the left ventricle, is shown passing upwards to curve backwards and downwards at **A.**, and the vessels which arise from it and pass to right side of head and neck and right arm, and left side of head and neck and arm, are shown in red, lettered only on the left side—**C.A.**, carotid artery, and **S.A.**, subclavian artery.

In blue are shown the veins, which bring the blood back to the right side of the heart—**J.V.**, jugular vein, and **S.V.**, subclavian vein.

B (in orange) is the left bronchial tube passing to the left lung under the arch of the aorta.

The plate indicates how the heart lies mainly to the left of the middle line, how, in the main, the right side is to the front, and, but for a small crescentic portion, the left side looks backwards. It will be seen also that a line drawn from the place where the 7th right rib cartilage joins the breast-bone, to the space between the 5th and 6th ribs within the line of the left nipple, will indicate the lower border of the heart.

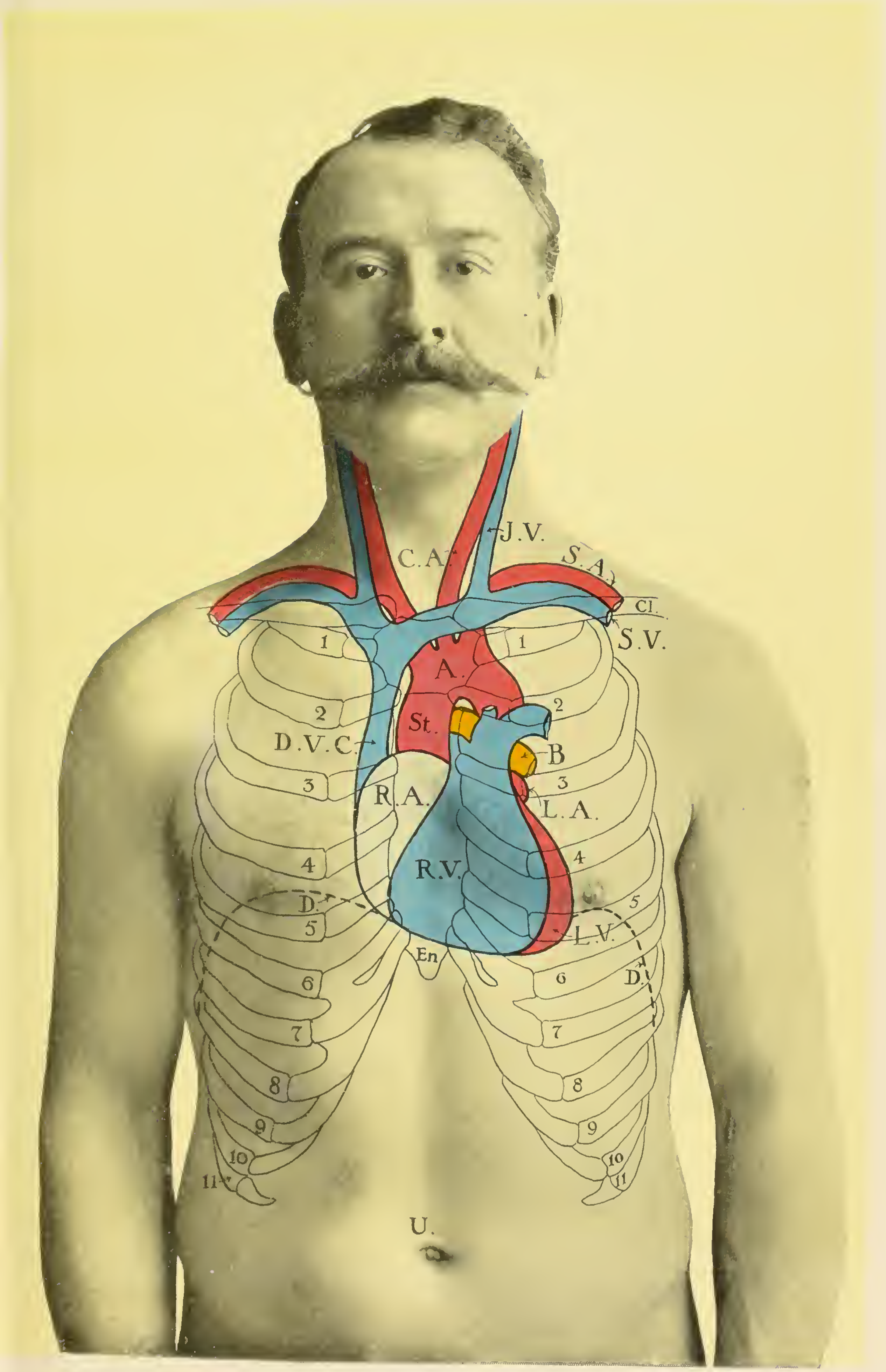
The left border of the heart will be indicated by a line drawn on the chest from the junction of the 3rd rib and its cartilage to the point already noted in the space between 5th and 6th ribs. The right border of the heart will be indicated by a line drawn on the right side from the place where the cartilage of the 3rd rib joins the breast-bone, to the place where the cartilage of the 7th rib joins the breast-bone, that line curving to the right of the breast-bone by 1½ inches. The division between the right auricle and ventricle will be indicated by a line drawn from the place where the cartilage of the left 3rd rib joins the breast-bone, downwards and across the breast-bone to where the cartilage of the 7th rib joins the breast-bone.

Thus a person might, by fixing these points on another person's chest, draw on the person's chest in chalk lines with fair accuracy the position of the person's heart within.

How the main vessel—**aorta**—is continued downwards behind the heart through the chest and into the abdomen, and how the blood is brought back to the right side of the heart by a great ascending vein, similar to the great descending one shown in this plate, are shown on Plate XXII.

But it must not be supposed from this plate that the heart lies bare in the chest. It is wholly surrounded by an investing membrane, the pericardium (see p. 298), and it is cushioned between the right and left lungs, only a small portion of it near the middle line being uncovered by the lungs (see Plate XIX).

PLATE XVI



THE TOPOGRAPHY OF THE HEART AND GREAT VESSELS OF THE CHEST

THE APPARATUS OF THE CIRCULATION.

(Refer to Plates XVI, XVII.)

The blood being the source of nourishment of all the tissues of the body, its need of constant renewal is apparent, for, otherwise, all nourishing material would speedily be abstracted from it. Moreover, tissues not only remove from the blood what they require, but they pour into it the waste products of their activity. If the blood were stagnant in the tissues it would thus not only be deprived of all nourishment, but would be loaded with waste and poisonous material. Therefore, as fresh blood must come constantly streaming to an organ or tissue, so must it as constantly flow away again, carrying impurities with it. The main idea of the circulation is thus easy to understand. There must be a central pump, so to speak, from which large pipes, to continue the illustration, pass off, leading to smaller and smaller pipes distributed throughout the whole body. The blood must be pumped into the large pipes and forced along till it reaches the smallest branches, so that it may have access to the remotest parts. There must also be a second system of pipes, by means of which the blood, after nourishing the tissues and being laden with their waste products, is brought back again to the central pump to be again distributed. Somewhere in this circuit there must be means for purifying the blood from the waste products it has received. Now this central pump is the **heart**, and the pipes leading from it and passing into smaller and smaller branches are the **arteries**, the fine vessels into which they ultimately pass being called the **capillaries**, while the pipes along which the blood is brought back to the heart are the **veins**. Of course there can be no break in the continuity between arteries and veins. The arteries, beginning large at the heart, become smaller and more numerous till they end in the fine, hair-like capillaries; and then the reverse process must go on, the blood passing, on its return journey, from smaller to larger vessels, till the large veins are reached which open into the heart. So that the arteries *end* in the tissues in fine, hair-like vessels—capillaries,—and the veins *begin* in the tissues in fine, hair-like vessels—capillaries,—and they must be mutually continuous, so that the capillaries of the arteries pass insensibly into capillaries of veins. Heart, arteries, capillaries, and veins form the apparatus of the circulation, and we must understand the apparatus before we proceed to examine the process of the circulation itself.

THE HEART.

The heart is a hollow organ made of muscle, whose fibres resemble, in some respects, those of voluntary muscle, described on p. 111, but differ from them in being beyond the control of the will, that is, involuntary. It is situated in the chest, between the right and left lungs, which partly cover it. Fig. 133 shows its position, and Plate XVI should be studied.

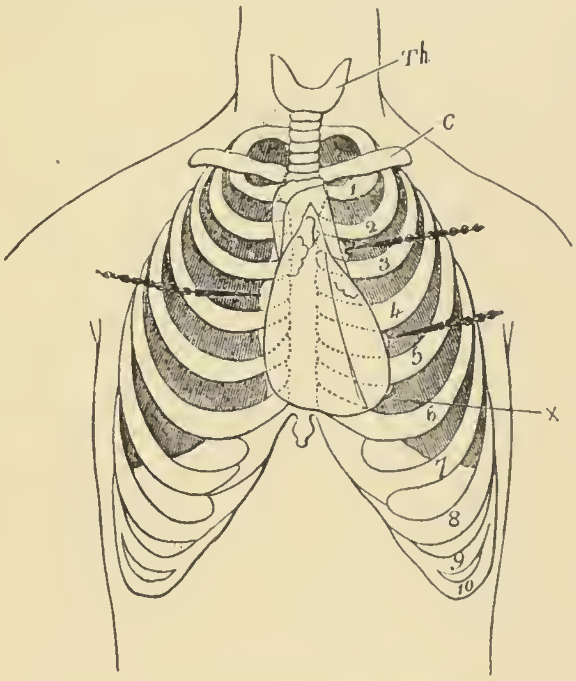


Fig. 133.—The position of the Heart and Lungs.

The lungs are represented shaded and drawn aside by hooks to show the extent of the heart, which is mapped out by continuous lines. *c* shows the position of the collar-bone, and 1, 2, 3, &c., indicate the ribs. The outline of the breast-bone and ribs in dotted lines marks the parts that would require to be removed to expose the heart fully in the body. X points to the apex of the heart, occupying a position between the fifth and sixth ribs. *Th* is the thyroid gland referred to on p. 281.

In **shape** the heart resembles a cone, the base of which is directed upwards. It lies, however, obliquely in the chest, so that the base is not only directed upwards, but also backwards and to the right side, while the point of the cone is downwards, forwards, and to the left side. The heart lies more to the left than to the right, but, as may be seen from the figure, it yet extends slightly beyond the middle line to the right. When the lungs are fully expanded only a small part of the front of the heart is exposed. One may easily map out on the chest of a healthy man the position occupied by the heart.

Let a straight line be drawn, in ink, across the chest on a level with the upper border of the cartilage of the third rib (see Fig. 20, p. 61), let a second line be drawn across at the level of the junction of the breast-bone and xiphoid cartilage (*q* of Fig. 20). These lines indicate the extreme limits which the heart reaches upwards and downwards in health. The extent to which the heart reaches on each side is marked by drawing one upright line at a distance of $1\frac{1}{2}$ inch to the right of the middle of the breast-bone, and a second upright line about $3\frac{1}{2}$ inches to the left of the middle of the breast-bone. The position of the apex is obtained by marking the spot where the heart is felt beating against the wall of the chest (× in Fig. 133), which is usually about 1 inch below, and a little to the right of, the left nipple in the space between the fifth and sixth ribs. With the aid of this mark, and within the lines, the outline of the heart may be drawn, and thus a good idea obtained of its position.

The average **size** of the heart is $4\frac{3}{4}$ inches long, $3\frac{1}{2}$ inches broad, and $2\frac{1}{2}$ inches thick. It is usually smaller in women than in men. It is roughly measured in individuals by the size of the closed fist.

The **coats** of the heart. The organ is suspended in the chest by the great vessels connected with it at the base, to be considered later; but it does not hang free. It is surrounded by a membranous bag called the **pericardium**. The bag is really a double one, consisting of two layers, one within the other, the inner one being closely adherent to the heart, and being separated from the outer one by a slight space, in which there is usually a small quantity of serous fluid—the **pericardial fluid**. The pericardium passes over the roots of the great vessels at the base of the heart, and it is here that the inner layer becomes continuous with the outer layer. A good idea of the pericardium will be obtained if one takes two thin paper bags, of which one is slightly smaller than the other, so that one may be contained within the other, both being fully distended. Now slightly fold back the edge of the mouth of the inner bag and gum it all round to the edge of the mouth of the outer one. There is now made a double bag with an inner and an outer layer, and a small space between them, completely shut off from the outside. Suppose the closed fist to be just large enough to fill the inner bag, it will represent the heart, to which the inner layer of the pericardium is adherent. The wrist will represent the great vessels passing off from the heart, around which the neck of the double bag extends. Part of the pericardium towards the apex is adherent, on the outside, to the diaphragm below — the muscular partition which separates the chest from the belly. The pericardium forms thus an outer coat or covering for the heart. Within it is the proper structure of the heart, the muscular structure, supplied, like all other muscles, with blood-vessels, nerves, lymphatics, &c. The muscular fibres are disposed in several layers, which appear to be spirally arranged with reference to one another. The inner lining is called the **endocardium**, and is very delicate.

The **chambers** of the heart. It has been said that the heart is a hollow organ, but the cavity is not single. A complete muscular partition divides it into two, so that there is a right and a left side, between which there is no direct communication except in the child before birth.

That partition or **septum** is indicated on the outside of the heart by a groove passing from the base to the apex, along which large blood-vessels run (Fig. 134). This partition, as the groove indicates, keeps to the right side of the apex, so that the whole of the apex is, by this division, on the left side. The two cavities thus formed are each divided by a partition into

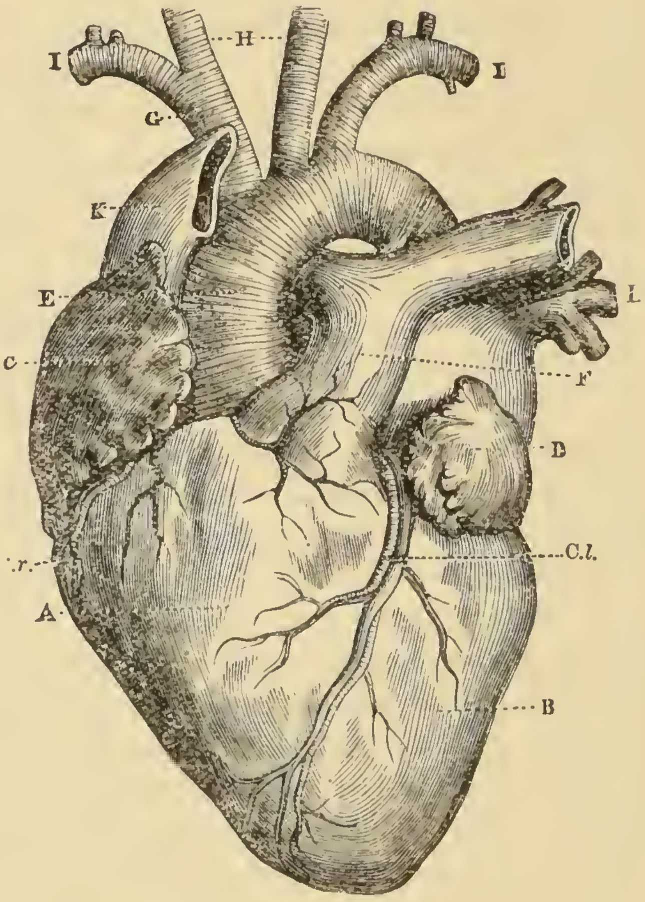


Fig. 134.—The Heart.

A and B, right and left ventricles. C and D, right and left auricles. E, aorta. F, pulmonary artery (shaded as a vein). G, innominate artery, branch of aorta. H, right and left carotid branches (to head and neck). I, I, subclavian branches (to upper limbs). K, superior vena cava. L, pulmonary veins. C *r.*, right coronary vessels. C *l.*, left coronary vessels. Arteries are marked by cross shading in the figure; veins are shaded lengthways.

an upper and a lower chamber. The partitions are not permanent, however, for they consist of flap valves, which, when closed, completely separate the upper and lower chambers, but which are capable of opening so that the chambers become continuous, just as folding-doors between two rooms, if closed, make them two separate rooms, but if open, make them practically one room. The heart has thus four chambers, two on each side. Fig. 135 shows them very well. It represents a heart cut open lengthways. From L the upright partition is seen passing, in a slightly irregular course, to M, and it is plainly shown how the apex is kept to the left. The cross partition is in the direction from E to G, and the four chambers are marked C, D, A, and B. Now the two upper chambers are called **auricles** (Latin *auricula*, the outer ear), from their supposed external resemblance to the ear (see Figs. 134 and 135, C and D). There are, therefore, the right and left auricles. The lower chambers are called **ventricles** (Latin *venter*, the belly), for they form the chief portion of the muscular substance of the organ, and there is a right and a left ventricle (Figs. 134 and 135, A and B). There is a great difference between the walls of the auricles and those of the ventricles, the former being thin and soft, the latter thick and strong and very muscular; especially is the increased thickness evident in the walls of the left ventricle. This difference is connected with the greater amount of work thrown on the ventricles and especially the left, as will be seen when the action of the heart is considered (p. 302).

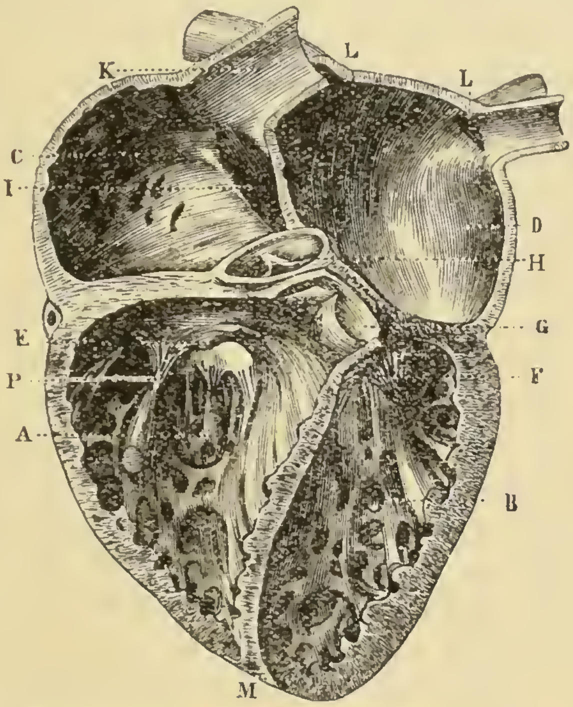


Fig. 135.—The Heart opened to show its Chambers.

A and B, right and left ventricles. C and D, right and left auricles. E, tricuspid, and F, mitral valves. G, pulmonary artery. H, aorta. I, opening of inferior vena cava. K, superior vena cava. L, L, orifices of pulmonary veins. M, termination of septum. P, papillary muscle.

The **valves** of the heart are most important structures. They consist of folds of the inner lining—endocardium—strengthened by fibres of connective and elastic tissue. One is situated in the narrow part between the right auricle and ventricle. It is called the **tricuspid valve**, because it consists of three cusps or flaps. In Fig. 135 E points to one flap. When the flaps are stretched across they completely close the communication between the upper and lower chamber. On the left side the valve in the narrow part between left auricle and ventricle consists of only two flaps, and is called the **mitral valve** (Fig. 135, F), because of its supposed resemblance to a bishop's mitre. When the valve is closed the flaps meet in the middle line and block the opening between the two chambers. When not stretched across, the flaps of both valves are hanging downwards into the lower chambers, and the passages between the auricles and ventricles are open so that the upper and lower chambers of each side are continuous. The passage on the right side, guarded by the tricuspid valve, is called the **right auriculo-ventricular opening**, that on the left side, guarded by the mitral valve, is called the **left auriculo-ventricular opening**. From the right ventricle a large vessel passes to the lungs—the **pulmonary artery**,—and from the left ventricle a large vessel goes off—the **aorta**. The openings of these vessels into the ventricles are guarded by valves—**semi-lunar valves**. Each semi-lunar valve has three flaps, and each flap is half-moon shaped, hence the term semilunar (*semi*, half, and *luna*, the moon). These valves, when shut, cut off the communication, on the right side between the pulmonary artery and the right ventricle, and on the left side between the aorta and the left ventricle. Most cases of heart-disease consist of some affection of one or other of these valves; and anything that interferes with their efficient opening or closing may produce most profound changes in every organ of the body. How this is possible will be perceived if the action of the valves is rightly understood.

Let us take the right side of the heart and consider it first. Blood, let us suppose, is pouring into the right auricle from veins that join it, bringing blood from all parts of the body. The tricuspid valve is open, its flaps hanging down into the ventricle. The blood, therefore, having entered the upper chamber, flows through the opening into the lower chamber;

but the auricle, being smaller than the ventricle, fills sooner. As soon as it is full the muscular walls are stimulated by the pressure of blood on them and contract vigorously. The contraction is accomplished at the expense of the cavity, just as, if a hollow elastic ball be squeezed by the hand, its cavity will be abolished, and the blood which filled the cavity is driven out. In what direction will it go? It may pass in two directions, either backwards into the veins, from which it has come, or downwards into the ventricle. But the mouths of the veins contract along with the auricle, and, besides, the veins are already full of blood, waiting the relaxation of the auricle to enter it. Thus all the blood will be driven down into the ventricle. The auricle having emptied itself begins to relax, and blood, entering from the veins, begins to fill it again. The ventricle contained already a considerable quantity of blood before the emptying of the auricle into it, and the additional quantity, received on the auricular contraction, just fills it. Its muscular walls are stimulated by the force of blood, and thus, as soon as the auricle has discharged its contents into it, the ventricle begins to contract. It contracts with much greater vigour than the upper chamber, because of the increased thickness and power of its walls, and the blood is driven out of it with considerable force. In what direction will it go? It may be forced upwards, back into the auricle, or it may be forced into the pulmonary artery, which passes, as already noted, from the right ventricle to the lungs. Now the tricuspid valve comes into play to determine which of these two directions the blood shall take. The free edges of the flaps are hanging downwards into the ventricle, but the blood is driven by the contraction against them, and forces them up so that the three flaps meet in the middle line and the opening is effectually closed. The action may be roughly illustrated thus: suppose a room filled with people, and the door of the room, which opens only inwards, to be standing half-open; suppose now a sudden movement of all the people towards the door, at once the door would be pressed on from behind, and would be speedily shut if the people were moving blindly onwards. The blood, therefore, is prevented passing backwards into the auricle. It is urged, then, into the pulmonary artery, which also is provided with valves, but they open away from the ventricle into the artery. The flaps are, consequently, pressed close against the wall of the artery and the passage is quite free. Suppose the room, already thought of, to have a second door, opening outwards into a passage; the stream of people pressing against it would drive it widely open so that the people might pass out. The ventricle remains contracted for a measurable period of time and then relaxes. The tricuspid valve, no longer pressed close, opens, partly forced to do so by the weight of blood now pouring into the chamber above it, and blood is again permitted to flow into the ventricle from the auricle. Now what is the purpose of the valves at the entrance to the pulmonary artery? While the ventricle remains contracted the blood, driven out of it, is being forced onwards along the artery to the lungs, but because of the ever-increasing smallness of the branches of the artery the blood encounters some resistance to its flow. As soon as the ventricle begins to relax, the pressure, urging on the blood from behind, is no longer exerted, and so the resistance in front tends to cause a back wave which would drive part of the blood back again into the ventricle. The back wave, however, gets behind the pouches of the semilunar valves, forces the three flaps to meet in the middle line, the passage is barred, and the return of any of the blood to the ventricle prevented. To return to our illustration: suppose the room to be emptied of the crowd, who have all passed into the passage, and suppose then the first of the crowd find their way along the passage not easy and try to return. At once the backward pressure of the crowd, catching the edge of the open door, will force it to close, and communication with the room will be cut off.

A similar series of occurrences is found to take place on the left side of the heart. The left auricle is filled with blood entering by veins. It contracts and forces the blood through the opening of the mitral valve into the left ventricle. A forcible contraction of the ventricle immediately follows; the blood, pressing against the flaps of the mitral valve, brings them together, thus preventing its passing up again into the auricle. It is forced to flow out into the artery arising from the ventricle—the aorta—whose valves open widely. As soon as the ventricle begins to relax, there is a tendency for the blood in the artery to recoil because of the resistance to its onward movement; and the back wave, getting into the pouches of the aortic semilunar valves, causes them to close, so that the return of blood to the ventricle is prevented.

Thus the valves determine the direction of the flow of blood through the heart. What is likely to arise should any of the valves fail from any cause to act properly, will be considered in detail under DISEASES OF THE HEART in the succeeding section. One example will, however, not be out of place here. Suppose the mitral valve to be incompetent, as the phrase goes, that is, not to shut completely. Then when the ventricle contracts, only part of the blood will pass into the aorta, and some will escape upwards into the auricle. The auricle, which already gets sufficient blood by the veins from the lungs, will always be over-full, and will be unduly stretched to accommodate the additional quantity. The blood will not pass on quickly enough, and the veins, in turn, will become over-full. The over-fulness will speedily pass backwards to the lungs. Its veins will become overcrowded, and a state of congestion will arise which may extend backwards to other organs—liver, stomach, &c.

We have not yet completely exposed, however, the wonderful character of these valvular arrangements. It would readily occur to one that the pressure of blood on the tricuspid and mitral valves, during the contraction of the ventricles, would not only be sufficient to raise the flaps to the horizontal position, but would force them beyond that, and make them open upwards into the auricles, so that the blood would still escape upwards. To prevent this there exists a remarkable arrangement. In the ventricles there are numbers of fleshy pillars projecting from the inner surface. They are called **musculi papillares** (papillary muscles). They have connected with their free points tendinous cords (**chordæ tendineæ**), whose other ends are fastened to the free edges of the valves. Now when the ventricles contract, these papillary muscles contract with them and pull on the cords. The cords are of such a length that when the valve is closed they become tight and a doubling upwards of the flap of the valve is thus prevented. In fig. 135, F points to the tip of one of the muscles, from which cords are seen passing off to a valve. As seen in that figure the inside of the heart is rough and irregular with bands of muscular fibres akin to the musculi papillares. Some of the bands, however, are connected at both ends with the muscular substance of the ventricle, others are like little cones of flesh projecting from the surface, with the apex free but with no tendinous cords. To them the term fleshy columns (**columnæ carneæ**) is applied. It is only to those from whose free extremity tendinous cords pass to the valves that the name papillary muscles is given. The semilunar valves of the pulmonary artery and aorta require no such cords, because they are not simply flaps connected by one edge only, but have a semicircular connection with the artery, just as a pocket may be sown on to a garment. Each of the three portions of the valve forms thus a little pouch, and when the three pouches are bulged out by the recoil of the blood they meet one another. The greater the backward force of the blood the more do the pouches press back to back against one another, and any doubling back is impossible. In fig. 135, G points to the entrance to the pulmonary artery opened up, and one pouch and a half are seen, while H indicates the entrance to the aorta cut across at the level of the valve. The shape of the pouches is in both slightly indicated.

Blood-vessels connected with the heart are numerous. They have been partly mentioned in the preceding paragraphs. Two large veins open into the right auricle, one at the upper part—the **superior vena cava**—and the other at the lower part—the **inferior vena cava.** The superior cava brings blood from the head, neck, upper limbs, and chest, being formed by the union of two venous trunks, one from the right side of the body and the other from the left. In Fig. 136, E marks the junction of the right and left trunks (K, K) from which the vena cava descends. The inferior cava is not shown in Fig. 136, being behind the parts there shown. It comes from below, and brings the blood from the lower part of the body. Thus these two large veins bring the blood from all parts of the body and pour it into the right auricle; and, as we have seen, this blood all passes down into the ventricle. From the right ventricle one large vessel arises—the **pulmonary artery** (the lung artery; Latin *pulmo*, the lung), which, at a distance of not more than 2 inches from the heart, divides into two branches of nearly equal size, one for the right lung and another for the left. Each branch, having reached the lung for which it is destined, gives off branches, and these branches again give off others, and so the branching goes on till it ends in fine delicate vessels, capillaries, forming a rich net-work in every part of the lung. Thus the blood, driven out of the ventricle into the pulmonary artery, is by the artery distributed in fine streams throughout the two lungs. Turn now to the left auricle. Four veins open into it, two coming from each lung—**pulmonary veins**, therefore. These veins arise in the lungs from the extremely fine vessels, which are the continuations of the capillaries of the pulmonary artery. The fine vessels unite to form larger vessels, and so on the process goes till two large veins are formed from each lung, which pass to the left auricle. The pulmonary veins, therefore, carry from the lungs to the left auricle the blood brought to the lungs from the right ventricle by the pulmonary artery, the same blood that previously entered the right auricle from the superior and inferior venæ cavæ. From the left ventricle one large arterial trunk arises—the **aorta**, the largest arterial trunk in the body (C, Fig. 136). It passes upwards in the chest for a short distance towards the root of the neck, where it gives off branches for both right and left arms, and right and left sides of the head. (See Fig. 136.) It then turns backwards and downwards and passes down along the back-bone, giving off branches on its way, and ending by dividing into branches for the lower limbs. It is the vessel from which branches arise which *convey* the blood to all parts of the body.

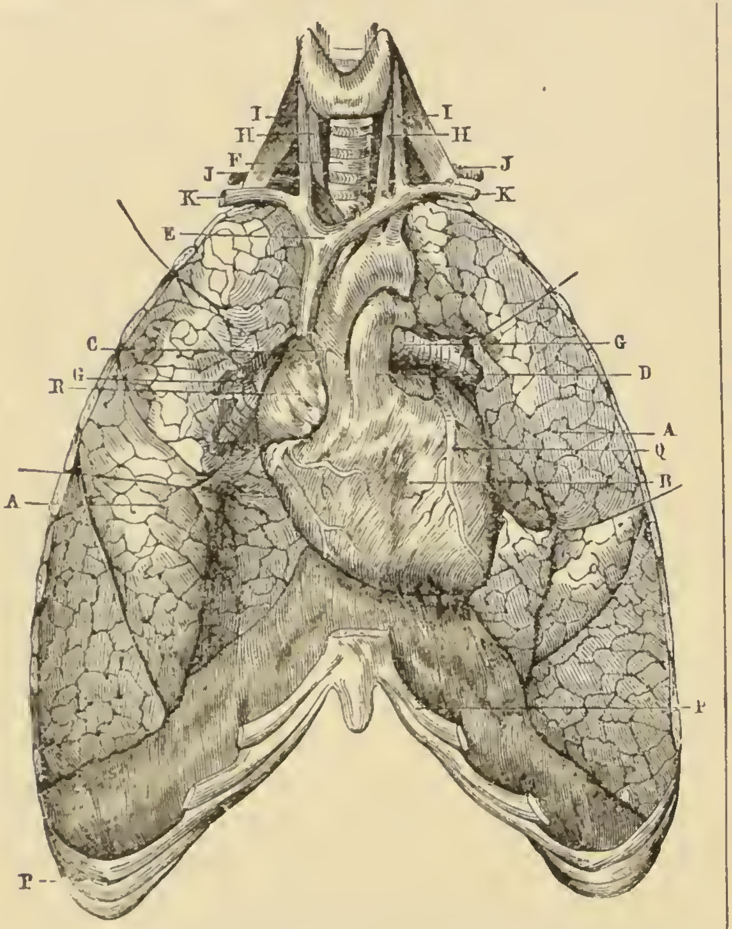


Fig. 136.—The Heart with its Blood-vessels and the Lungs.

A, the lungs pulled aside in front to show the heart, B, and the bronchial tubes, G, G. C, the aorta. D, the pulmonary artery. E, the superior vena cava, formed by the junction of the veins (subclavian) from the right and left sides, K, K. F, the windpipe. I, I, veins from the head and neck (jugular) joining K, K. H, H, arteries (carotid) to head and neck. J, J, arteries (subclavian) passing to right and left sides. P, P, ribs. Q, coronary artery. R, right auricle of heart.

Thus we see that the blood, collected from all parts of the body, enters the right side of the heart by the right auricle, and is poured down into the right ventricle, from which it is forced along the pulmonary artery through the lungs. It is there collected by the pulmonary veins and carried to the left auricle, poured into the left ventricle, and from it forced into the aorta, by the branches of which it is conveyed to every part of the body, only to be again brought back to the right side of the heart. As we shall see in Section XVI., a chief object of distributing the blood through the lungs is to have it purified from certain waste substances which it has received in its course through the body, before it is again sent on its journey from the left ventricle. [The various blood-vessels that have been mentioned are shown in Figs. 134 and 136.]

The means by which the muscular substance of the heart is nourished remain to be considered. Close above the semilunar valves of the aorta there arise two arteries—the **coronary arteries**, one of which passes to the right side of the heart and the other to the left. In Fig. 134 c. *r.* points to the right coronary artery, and c. *l.* to the left. Between them these vessels carry sufficient pure blood to nourish the heart. After circulating through the heart substance the blood is collected by **coronary veins**, which pour it into the right auricle. Thus the heart gets its own share of the nourishment which it is its business to drive through the body.

THE ACTION OF THE HEART.

The heart being the chief instrument in maintaining a steady flow of blood through the body, its action must be methodical and regular. It does not contract as a whole. The two auricles contract at the same instant, and the contraction of the two ventricles immediately follows. While the ventricles are contracting, the auricles begin to relax, and after the ventricles have contracted they also relax. There is a period, following the ventricular contraction, when the whole heart is at rest, till the auricles again contract. The order of events is thus—contraction of auricles, contraction of ventricles, pause, contraction of auricles, contraction of ventricles, pause, and so on. The contraction is called **systole**, and the relaxation **diastole**, so that the order of events might be stated as systole of the auricles, immediately followed by systole of the ventricles, and thereafter a period during which the whole heart is in diastole. The occurrences follow one another so regularly as to be called *rhythmic*, and, on that account, the rhythm of the heart's action is spoken of. Suppose the heart to be beating 65 to 75 times a minute, which is the average, the time occupied from the instant the auricles began to contract till, after the contraction of the ventricles and the pause, they began to contract again, would be less than a second. Of this time ⅕th is occupied by the contraction of the auricles ⅖ths by the contraction of the ventricles, and the time during which the whole heart is at rest is ⅖ths of the period. We know, from what has been said in previous paragraphs, that during the contraction of the auricles the blood is being poured down into the lower chambers, that immediately after they have emptied themselves they begin to relax and to be refilled from the veins, that during the ventricular contraction the blood is being forced into the arteries, the pulmonary artery on the right side, and the aorta on the left, and that during the relaxation both auricles and ventricles are refilling. We know also that during the ventricular contraction the tricuspid and mitral valves are closed to prevent the return of blood to the auricles, while the valves of the arteries are open to permit of the blood passing into them, and that during the relaxation the tricuspid and mitral valves are open, while the valves of the arteries are closed to prevent the return of blood to the ventricles.

The Beat of the Heart.—These occurrences are attended by various others worthy of note. The first of these is the beat of the heart. If the hand be laid flat on the chest over the region of the left nipple, the heart will be felt beating against the chest wall. This is due to the fact that, by its sudden and vigorous contraction, the point of the heart is jerked forwards against the chest wall. The impulse should be felt in the space between the fifth and sixth ribs, an inch below and a little to the right of the left nipple. It is important to know this position, for the heart is sometimes displaced by disease, and the beat indicates its new position.

Sounds also accompany the heart's action. If the ear be applied over the heart, two sounds will be heard following one another with perfect regularity. They have been imitated by uttering the syllables *lupp, dupp*. One is heard immediately after the other, then there is a pause, and then the two sounds again; and so on. They are distinguished by being called the *first sound* and the *second sound*. The second sound is short and sharp as compared with the first. It is not certain what the first sound is due to, but while it is being produced the ventricles are contracting, the tricuspid and mitral valves are closing, the blood is rushing into the arteries, and the heart is driven against the chest. The second sound has been conclusively shown to be caused by the closing of the semilunar valves of the pulmonary artery and aorta, and while it is being produced the ventricles are relaxing, and the blood is entering both upper and lower chambers. These sounds afford indications of the greatest importance in the detection of heart-disease. For, if the valves of the heart are diseased, the sounds will be either accompanied or replaced by blowing murmurs, owing to the blood rushing past roughened surfaces, and if one can detect which sound is associated with the murmur, the valve affected may be determined and the exact position of the disease fixed.

Work of the Heart. — Work done by an engine may be measured by the weight it can lift through a certain distance, or the distance through which it can lift a certain weight. Thus if one were to say a load of 100 pounds was lifted 1 foot high, a perfectly accurate idea of the work done would be gained, and it would amount to the same thing if a weight of 1 pound were lifted 100 feet high. Thus work done is measured by "foot-pounds," that is, the number of pounds weight lifted multiplied by the number of feet through which it was lifted gives the work done. The same method can be applied to measure the work done by the heart. With every contraction of the ventricle 6 ounces of blood are forced into the aorta. It has been found that if the blood were thrown out freely, it is sent out of the ventricle with such force that it would rise to a height of 6 feet. Thus with every stroke of the ventricle the work done is equal to raising 6 ounces 6 feet high, or, what is the same thing, 36 ounces 1 foot high. But 36 ounces are 2¼ pounds; therefore, the force exerted by the ventricle at each beat is equal to 2¼ foot-pounds. Suppose the heart beats 70 times a minute, 2¼ multiplied by 70 are equal to a force of 157½ foot-pounds exerted by the left ventricle in one minute. Multiply 157½ by 60, the number of minutes in an hour, and then by 24, the number of hours in a day, and the result is 226,800 foot-pounds of work performed by the left ventricle in a day. If we add to this the work done by the right ventricle, it would equal, by a rough estimate, 300,000 foot-pounds per day, that is, 300,000 pounds lifted 1 foot high; that is, a sufficient force is developed by the heart in one day to raise the body of a man, weighing 150 pounds, 2000 feet in the air. That force seems enormous. It is worth noting the conditions of its development. They are: *proper nourishment*, conveyed to the heart's substance by its own system of coronary vessels, and *a regular alternation of work and rest*, for we have seen that during the period of its round the heart works three-fifths of the time and rests two-fifths.

Nervous Control of the Heart.—The regular rhythmic movement of the heart is maintained by nervous influence. If a frog be suddenly killed by a blow on the head, and the chest be immediately opened, the heart will be found still beating. If a long piece of straw, fixed at one end, be laid over the heart, the free end will move up and down, showing and exaggerating the movement. More than this, the frog's heart can be entirely removed from its body, and attached to tubes filled with nourishing fluid, from which the heart is replenished at intervals. By this means the heart can be kept beating vigorously for a whole day or more, and observations made. It has been ascertained by these and similar means that, at various places in the substance of the heart, there are nervous ganglia, that is, masses of nervous matter. It is from certain of these that there proceed, at regular intervals, discharges of nerve energy, which excite the movement. All of the ganglia, however, do not seem to excite movement; the business of one of them seems to be *to restrain.* If the exciting ganglia had it all their own way, the heart would go on contracting at a speed that would be quickly exhausting, and if the restraining ganglion had it all its own way, the heart would stand still. The one influence, however, modifies the other, and the result is a moderate and regular activity of the heart.

Now these nervous arrangements are within the substance of the heart itself; but the organ is subject to influences from outside of itself. Two nerves are connected with the heart, the pneumogastric nerve (p. 152) and the sympathetic (p. 152). If the pneumogastric be excited by electrical shocks or in other ways, the heart slows, and, if the excitement be strong enough, stops beating, in a condition of complete relaxation and fully distended; if the sympathetic be stimulated, the heart quickens its movement, beats faster and faster, until, if the stimulus be strong enough, it stops, but this time in a condition of complete and rigid contraction. It would, therefore, appear as if the sympathetic were connected with the exciting ganglia of the heart, and as if the pneumogastric were connected with the restraining ganglion.

Now let us observe how these nervous relations act in ordinary life. A person is the subject of some emotion, and his heart is beating faster than usual; that means that the excitement is communicated from his brain by sympathetic nerves to the heart, which it stimulates to increased activity. When a person receives a blow on the stomach which causes him to faint, the explanation is that the blow has produced a profound impression on certain nerves in the belly, which have conveyed the impression to the brain, and from the brain the impression has, in turn, been carried down to the heart by the pneumogastric nerves, causing the heart to cease beating for an instant. This is of the nature of a reflex action (p. 132). If the effect on the heart be so great as to restrain its movements for any appreciable time, death is the result. It is in a similar way that sudden shocks of any kind, severe pain, &c., cause fainting, the restraining influence exerted on the heart by the stimulation of the pneumogastric momentarily suspending its movements.

THE BLOOD-VESSELS.

There are three kinds of blood-vessels, capillaries, arteries, veins, which differ from one another in various particulars.

The Structure of Capillaries will be first described, since they are the most delicate vessels. They are very fine tubes formed by long flattened cells united edge to edge. This is shown by staining with nitrate of silver a fine tissue, such as the inner membrane of the brain, the pia mater (p. 136), which contains capillaries in abundance. On then examining the tissue with the aid of a microscope, delicate vessels are seen traversing it in all directions. The nitrate of silver stains darkly the cement substance between the cells, and thus the fact of the vessel being made up of cells is revealed. This is shown in Fig. 137, *a*, where the clear areas, mapped out by the irregular dark lines, are the cells. A smaller vessel similarly stained is seen at *b*. At *d* in the figure (where the cells are not mapped out by staining) there is represented a smaller capillary giving off branches so fine that the blood corpuscles would require

PLATE XVII

THE GENERAL DISTRIBUTION OF THE BLOOD-VESSELS OF THE HUMAN BODY

THE ARTERIES ARE SHOWN IN RED, THE VEINS IN BLUE

H, the **heart**; l, left side, r, right side.

Arising from the heart is the main artrey, aorta (**A**). The letter is put on the vessel at some distance from the heart, near where it gives off the branches (in red) for the head and arms, and at the point where it arches backwards and downwards to pass through the chest and belly till at **A′** it gives off branches for the legs.

Running alongside of the arteries are represented in blue, **veins** (see pp. 307-308).

At **K** is represented the position of the **kidneys** and their veins.

L represents veins of the **lung.**

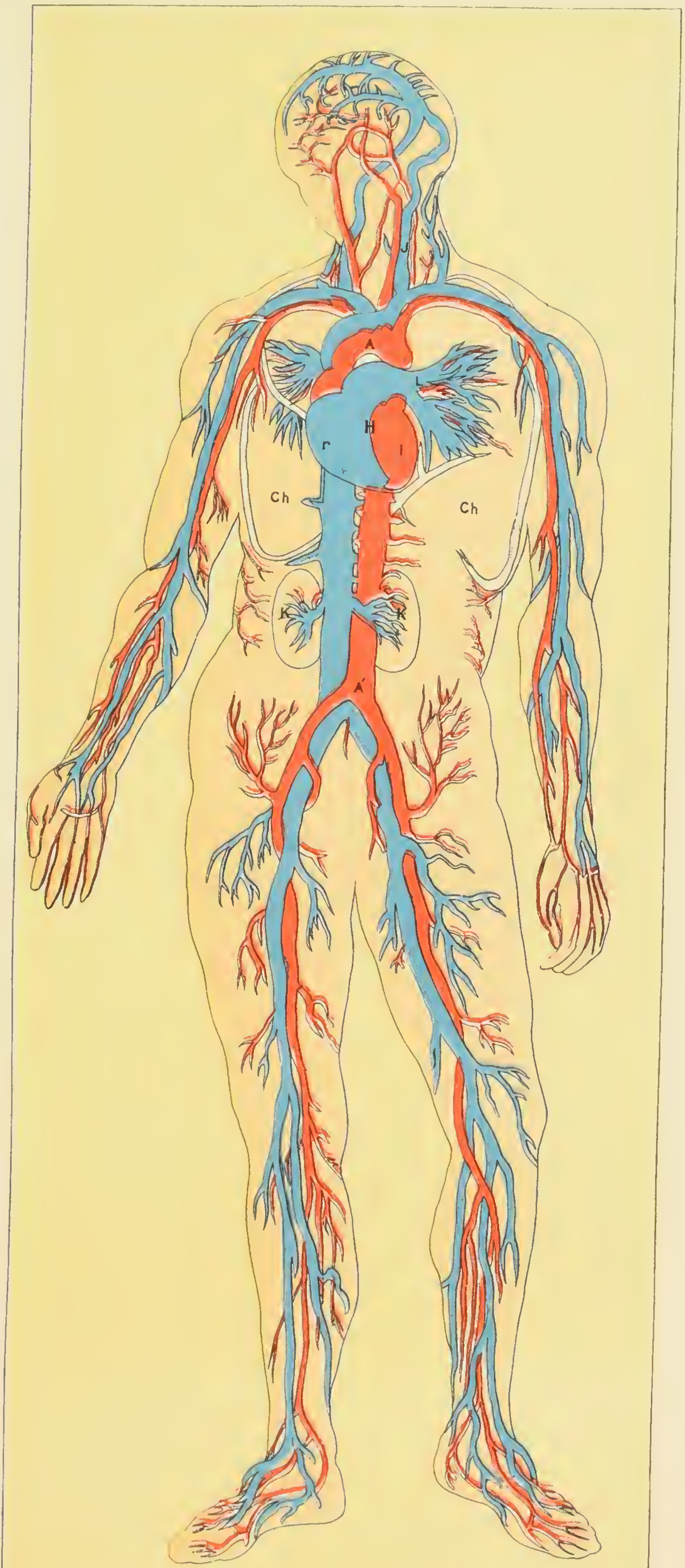
J, jugular vein.

Ch, outlines of the **chest.**

THE GENERAL DISTRIBUTION OF THE BLOOD-VESSELS.

THE ARTERIES ARE SHOWN IN RED, THE VEINS IN BLUE

Plate XVII



to travel through them in single file. These are the finest branches, and have no greater diameter than the $\frac{1}{2000}$ to the $\frac{1}{3000}$ of an inch. In *b* and *d* a small body is seen in the centre of each elongated cell. It is a nucleus (p 53).

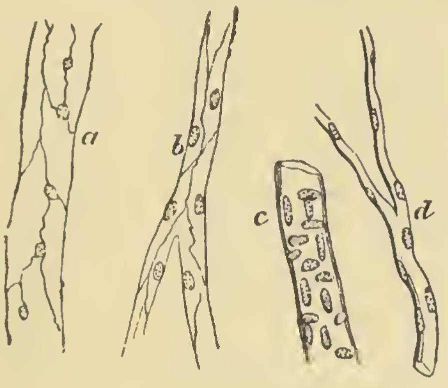


Fig. 137.—The Structure of Capillaries.

Now, in vessels larger than capillaries, outside of this layer of cells there are various coats of fibrous, elastic, or muscular tissue, according to the size of the vessel and the strength which it is necessary for it to possess.

The Structure of Arteries.—Arteries have as their innermost coat—the coat next to the channel of the vessel—a delicate membrane consisting of cells precisely similar to the wall of the capillaries. Outside of this is a coat of fibrous tissue with an abundance of elastic fibres in it. Outside of this again is what is called the *middle coat*, consisting of elastic tissue and fibres of involuntary muscle disposed circularly round the vessel. These coats are indicated in Fig. 138, which represents an artery dividing into two branches. *a a* point to the inner lining membrane of cells, *b b* to the middle muscular coat, which has been acted on by acetic acid to show the nuclei of the cross muscular fibres; and *c c* point to the outer coat. Fig. 137 *c* represents a small artery or vein in which the nuclei of muscular fibres running both lengthwise and across are shown. The outer coat of an artery consists mainly of fibrous tissue, also with elastic fibres. In the large arteries the elastic tissue predominates, while in the small arteries the muscular coat is more abundant. Thus the feature of the large arteries is their elasticity, while that of the small is their contractility. The importance of this is spoken of on p. 310.

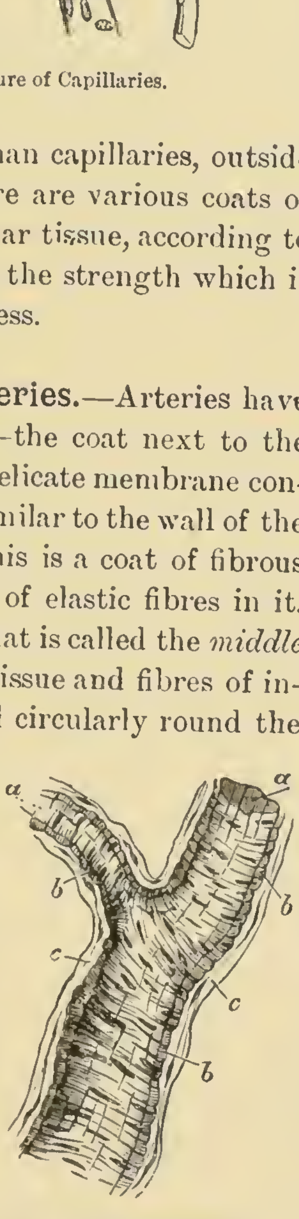


Fig. 138.—Structure of an Artery.

The **structure of veins** is practically the same as that of arteries. They have the same coats, but they are much thinner and more soft. There is also this other difference, that the veins, with some exceptions, have valves, which are directed towards the heart and permit the blood to flow in that direction, while preventing its flow in the opposite direction. In a dead animal an artery may be distinguished from a vein by the stoutness and firmness of its walls, while those of the vein are soft and yielding. Also, on cutting through the artery, owing to the thickness of its walls, the tube will be seen to remain open, while the walls of the vein are collapsed and folded on one another. Arteries are in the dead animal generally found empty, the veins only containing blood. It was this observation that led old anatomists to give the name arteries (*arteria*, an air-vessel) to the strong open vessels, because, finding them always apparently empty, they thought that in life they contained the animal spirits.

The **functions of the various vessels** will be noted in discussing the details of the circulation.

THE DISTRIBUTION OF THE BLOOD-VESSELS.

(Plate XVII.)

The Arteries of the Head and Neck are among the earliest that spring from the main trunk, arising from the heart—the **aorta**. The aorta passes upwards a short way in the chest, as high as the level of the upper border of the second rib, and it then arches backwards towards the back-bone, which, having reached, it turns downwards and passes down through the chest, lying close against the left side of the back-bone. At the arch three branches come off to supply the neck, head, and upper limbs. They are seen in Fig. 134 (p. 298). The first of the three (G in the figure) is called the **innominate artery** (the unnamed artery). It passes towards the right and is very short, splitting into two branches when behind the junction of the collar-bone and breast-bone. One of the branches (I) is the **subclavian artery**, which arches across the lower part of the neck behind the collar-bone on its way to the right arm, giving off branches to the head, neck, and chest in its course. In Fig. 139 the number 12 points to a part of it that is least covered by muscles. The other branch (II in Fig. 134) is the **common carotid artery** of the right side. It passes up the side of the neck, running alongside of the windpipe and larynx, to the level of the angle of the jaw. Here it divides into two. An external portion—the **external carotid**—passes up in front of the ear, where it ends in branches to the neck, face, and outer parts of the head. The other branch—**internal carotid**—passes deeply into the neck, and, through an opening in the skull behind the ear, enters the brain, supplying it and the eye with blood. Fig. 139 shows slightly the ramifications of these vessels over head and neck. It is to be noted that in the neck the carotid artery lies deeply under muscles so as to be well protected from injury, but that the external carotid comes more near the surface about the angle of the jaw. The arteries of the left side are similarly disposed, but their origin is slightly different. The common carotid artery and the subclavian artery of the left side arise, each separately and not by a common trunk, from the arch of the aorta, as shown in Fig. 134, p. 298.

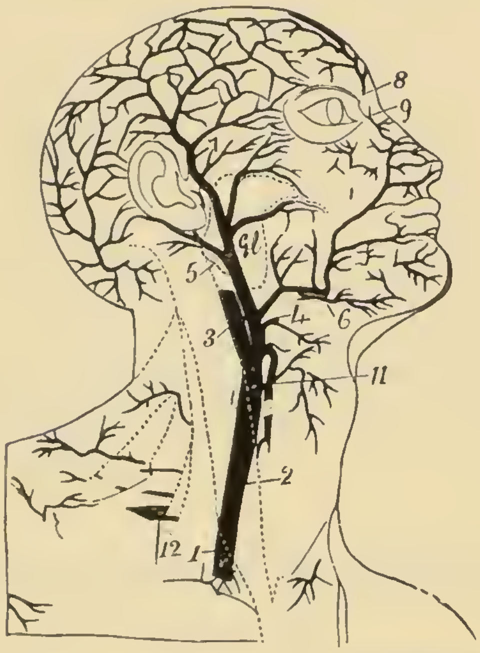


Fig. 139.—Arteries of the Head and Neck.

1 and 2, the common carotid artery, 2 being the part covered by muscle as indicated by dotted lines; 3, the internal, and 4, the external carotid. Some branches of the external carotid are shown, 5 to parts behind the ear, 6 to parts under the chin, 7 to the side of the head, and 9 to the nose. 8 points to a branch of the internal carotid which comes out from within the skull above the eye and is distributed over the forehead. 11 is a branch passing down to the front of the neck. 12 points to part of the subclavian artery. *Gl* shows the position of the salivary gland.

Arteries of the Upper Limb.—The subclavian artery, mentioned above, after passing under the collar-bone and over the first rib, takes its course through the arm-pit to reach the arm. In the arm-pit it is called the **axillary artery**. When it has entered the arm it is called the **brachial artery**. In its passage through the arm-pit the vessel furnishes branches to the chest and shoulder. Fig. 140 indicates the general course of the vessel in the arm and its distribution. If the arm be held straight out from the side, palm up, the course of the vessel is indicated by a line right through the centre of the arm-pit and over the arm to the middle of the front of the elbow. In its course through the upper arm it is covered by little besides skin and fat; and it gives off branches to the muscles and bone. It becomes deeper at the elbow and there divides into two (Fig. 140), one artery for the radial or thumb side of the forearm—the **radial artery**, and the other for the little finger or ulnar side—the **ulnar artery**. The former passes down to the wrist, where it winds round to the back of the wrist and then reappears in the palm between the thumb and first finger. The ulnar artery runs to the wrist and passes into the palm, as shown in the figure. The ends of both arteries form arches in the palm, a superficial arch formed by the ulnar, and a deep arch formed by the radial; from the arch near the surface branches proceed to each side of the fingers, and from the deep arch deep muscles and the back of the hand are supplied. It is by the radial artery at the wrist that the pulse is felt. The ulnar artery supplies a branch near the bend of the elbow, which proceeds deeply into the forearm and gives offshoots to the back of the forearm.

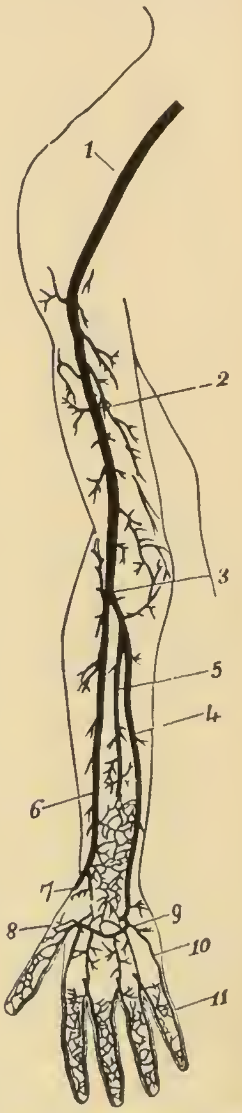


Fig. 140.—Arteries of the Front of the Arm.

1, the axillary artery; 2, the brachial artery, dividing at 3 into 6 the radial, and 4 the ulnar artery, the ulnar giving off a deep branch 5. 7, the radial artery winding round the back of the wrist to re-appear at 8. Between 8 and 9 the superficial arch in the palm giving off branches, as 10, to end along the side of the finger, 11.

Arteries of the Lower Limb.—It has been mentioned that the aorta passes down through the chest, lying alongside of the back-bone. On its way it gives off branches to the organs of the chest—the **bronchial arteries** to the air-tubes of the lungs, branches to the gullet, branches—**intercostal**—which run between the ribs, &c. In its descending course the aorta passes through the diaphragm (p. 345) and enters the cavity of the belly. Here a short thick trunk leaves it—the **cœliac axis**—from which arteries arise for the stomach, liver, and spleen.

A little farther on its way it gives origin to two **mesenteric arteries**, for the supply of the intestine. Similarly other branches pass off from the aorta in the belly for the kidneys—**renal arteries**. Low down on the front of the back-bone the aorta, as such, ceases by splitting into two large vessels—the **common iliac arteries**—one of which passes to the right, the other to the left. Each one of these speedily splits into two branches, of which one, the **internal iliac artery**, goes deeply into the pelvis (p. 63), supplying the muscles and organs there, bladder, &c., and gives off vessels to the buttock, while the other, the **external iliac artery**, issues from the belly about the middle of the groin. This vessel, when it has appeared in the front of the thigh, is called the **femoral artery**. Its general course is indicated in Fig. 141. A line drawn from the middle of the groin over the front of the thigh to a little above the inner side of the knee-joint would pretty accurately map out its course. One noteworthy feature of it is that in the upper third of the thigh it is covered only by fat and skin, but after that it passes deeply into muscles. It is, therefore, over this upper portion in front of the thigh that pressure is exerted (as shown under Accidents and Emergencies) to block the vessel and so prevent further bleeding, otherwise uncontrollable, from any part below. The artery gives off many branches in its course, for the supply of the thigh and other parts. Having reached the inner side of the lower part of the thigh, the vessel passes backwards into the ham, or popliteal space, as that part is called by anatomists, where it receives the name of **popliteal artery**. It courses through the middle of this space over the knee-joint, giving off numerous twigs to muscles and to the joint on its way. Below the knee-joint it ends by dividing into two. The course of one of the two, the **posterior tibial artery**, is shown in Fig. 141, as it passes down the inner side of the leg to the ankle, where it ends in branches for the sole of the foot. In Fig. 142 is represented the course of the other branch, called the **anterior tibial artery**. Beginning below the knee on the outer side of the leg it courses down the leg towards the middle of the front of the ankle, buried deeply under muscles till it nears the ankle. Its continuation proceeds over the back of the foot to the space between the great and second toes, through which it passes to join vessels in the sole. Fig. 142 indicates how its branches supply the back of the foot.

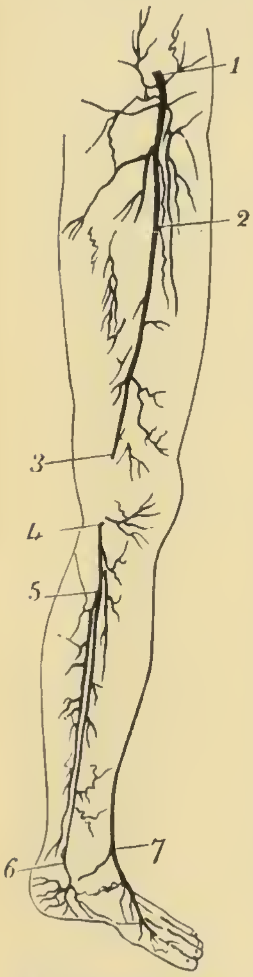


Fig. 141.—The Arteries of the Lower Limb.

1, the femoral artery, passing deeply into the thigh at 2 and winding into the ham at 3; 4, its posterior tibial branch, which passes to the ankle at 6, giving off a large branch at 5; 7, part of the anterior tibial artery shown in Fig. 125.

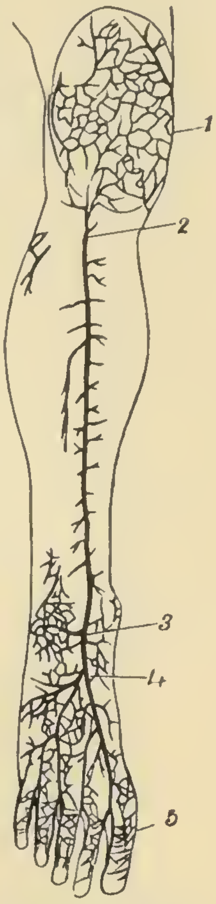


Fig. 142.—Arteries of the Front of the Leg.

1, an indication of the blood supply over the knee-joint; 2, the anterior tibial artery, passing to 3, the ankle, continuing over the back of the foot, 4 and 5, giving off twigs.

From this brief account of the general distribution of the arteries in the body it will be seen how all the arteries arise, directly or indirectly, from one large trunk—the aorta—proceeding from the left ventricle of the heart.

Veins of the Head and Neck.—The general arrangement of the surface veins is indicated in Fig. 143. They are seen converging towards three main vessels, namely, the **external jugular vein** (2 in the fig.), the **internal jugular vein** (3), and the **anterior jugular vein** (4). Of

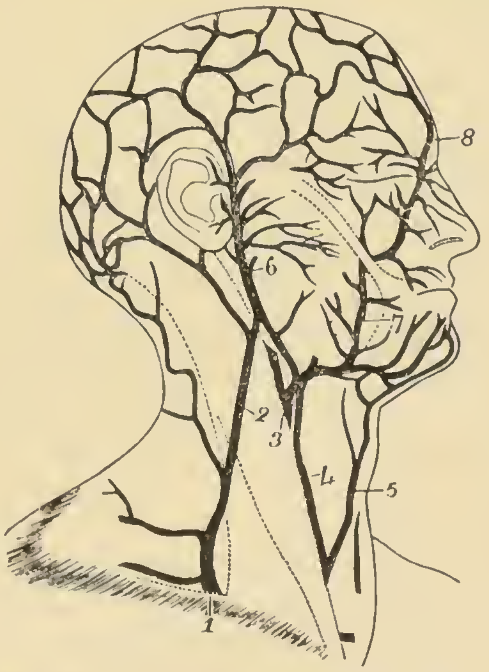


Fig. 143.—Surface Veins of the Head and Neck.

1, 2, external jugular; 3, internal jugular; 4, 5, anterior jugular; 6, vein formed by junction of veins from head and jaw going on to the external jugular; 7, vein of the face; 8, vein of the forehead.

these the **external jugular** begins near the angle of the jaw by the union of a vein from the head and deep parts of the jaw (6) and a vein from the region behind the ear. It passes over the sterno-mastoid muscle (shown in dotted outline) to disappear behind the collar-bone at (1), where it joins another large vessel, the **subclavian vein.** It is a vessel very near the surface and liable to injury. The internal jugular receives blood from the cavity of the skull and descends in the neck along with the common carotid artery. It is thus placed deeply in the neck and mostly covered by the sterno-mastoid muscle. It joins the subclavian vein, as shown in Fig. 136. In Fig. 143 it is shown receiving a large branch from the face. The **anterior jugular vein** runs down the neck near to the middle line and joins the external jugular behind the sterno-mastoid muscle. Thus directly or indirectly the veins of the head and neck, which carry the blood from that region back to the heart, all join the subclavian vein, (see Fig. 136), which is a continuation of the large trunk carrying the venous blood from the upper limb. On each side the subclavian vein, just at its point of junction with the internal jugular, passes on to a short trunk, called the **innominate vein,** and the two innominate veins, one from each side of the body, join to form the **superior vena cava** (E, Fig. 136), which passes to the right side of the heart. Thus all the blood distributed to the head, neck, and upper limbs is brought back to the heart by one large venous trunk.

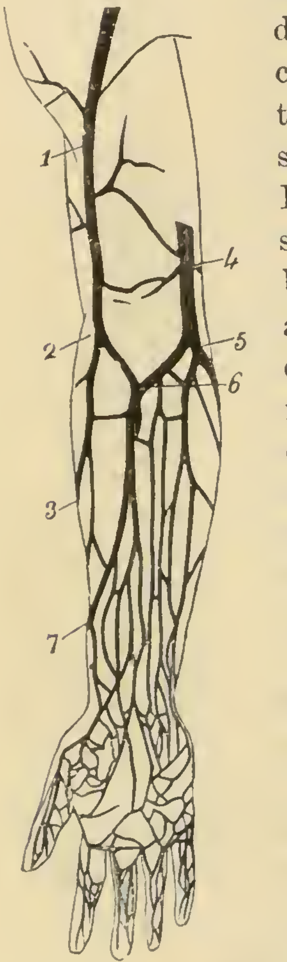


Fig. 144.—Surface Veins of the Hand and Arm.

1, the cephalic vein; 2, 3, radial vein; 4, basilic vein, formed by 5, ulnar vein, and 6, branch of median vein, 7.

Veins of the Upper Limb.—Fig. 144 shows the surface veins of the hand and forearm, uniting to form three main trunks, 3, the **radial vein**, which begins on the back of the hand, 7, the **median vein**, formed by the union of small vessels of the palm of the hand, and 5, the **ulnar vein**, which commences on the inner side of the back of the hand and receives a large branch from the front of the forearm. These vessels form a peculiar arrangement at the elbow, shown in Fig. 144, the median vein, at 6, giving off a branch at one side to the vein marked 4, the **basilic vein**, and a branch at the other side to the **cephalic vein**, marked 1. It is the branch between 6 and 5 that is usually opened in the operation of bleeding at the arm. The two large veins, cephalic and basilic, pass up the arm. The latter, which in the figure is represented as disappearing a little above the elbow, courses up the inner side of the arm a little more deeply than it is at the elbow, and passes through the arm-pit, being then called the **axillary vein**, over the margin of the first rib and so behind the collar-bone. Here it is called the **subclavian vein**, and its farther course has been already noticed. The cephalic vein joins the axillary.

Besides the veins named there are veins deeply placed in the substance of the upper limb, accompanying the branches of arteries. These all in the end join the axillary vein. Thus this one large vessel carries from the arm all the blood brought to it by arteries.

Veins of the Lower Limb.—Fig. 145 shows the surface veins of the inner side of the leg and foot. One large vein is there seen. Beginning in branches from the inner side of the foot it passes up the inner side of the ankle to the inner side of the knee and thence to the front of the thigh, where at 1 it dips inwards to end in a vein lying alongside of the femoral artery (p. 307). This is the **internal or long saphenous vein.** Over the outer ankle and outer side of the leg the **short saphenous vein** runs, but only to the ham, into which it penetrates to join a deep vein.

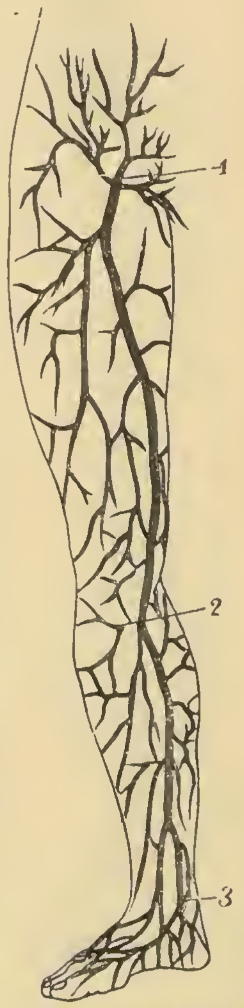


Fig. 145.—Surface Veins of the Inner Side of the Lower Limb.

1, 2, 3, internal saphenous vein.

Deep veins in the lower limb accompany the arteries, the course of some of which has been noted (p. 307). The **femoral vein**, which lies side by side with the femoral artery, passes through the groin into the cavity of the belly to end in the **external iliac vein**, lying alongside the artery of the same name. This vein, carrying all the blood from the lower limb, is joined by the **internal iliac vein**, bringing blood from the buttocks and pelvic organs and cavity. Together they form the **common iliac vein**. The common iliac veins, one from each side of the body, unite near the lower end of the backbone to form the **inferior vena cava**, which passes upwards in the cavity of the belly, receiving additions from the organs there, from liver, kidneys, &c., pierces the diaphragm, and enters the right side of the heart.

Thus the inferior vena cava brings all the blood from the lower limbs and belly to the right side of the heart, as the superior vena cava performs a like office for the upper part of the body.

The Azygos Veins are two veins, one for each side, which collect the blood that has been distributed in the chest by arteries running outwards between the ribs, and in the belly by arteries pursuing a similar course. The vein of the right side (**vena azygos major**) is larger than the one of the left side (**azygos minor**). The latter joins the former in the chest, while the major vein enters the superior vena cava.

Thus all the blood which has been distributed from the left ventricle of the heart throughout the body by the branches of one large arterial trunk—the **aorta**—is returned to the right auricle of the heart by two large veins, the **superior vena cava**, coming from the head, neck, and upper limbs, and the **inferior vena cava**, coming from the belly and lower limbs. On p. 302 it has been described how the blood which enters the right auricle of the heart ultimately reaches the left ventricle, having passed through the lungs and been purified.

THE CIRCULATION OF THE BLOOD.

THE SYSTEMIC CIRCULATION.

The circulation of the blood throughout the whole body is similar to the circulation through the lungs already described (p. 302). The former is called the **systemic or great circulation**, the latter the **pulmonary or lesser circulation**.

The blood which fills the left ventricle is, by contraction, forced into the aorta, which is already filled with blood, so that to make room for the extra quantity the vessel must distend, and the blood already in it must be forced onwards. As this is happening many times in a minute the blood in the aorta is continually being forced into its branches. Now, as we have seen, it gives off branches to every part of the body, to head and neck, to the upper limbs, to the chest and the organs in it, to the organs contained within the belly, and to the lower limbs. So that, to every region of the body, from the crown of the head to the sole of the foot, blood is being carried by arteries. As these arteries penetrate into the various regions and organs of the body they give off branches, which are continually becoming smaller, till they become microscopic in size and are found penetrating every part. The smallest arteries end in thin-walled capillaries, which form such a close net-work that a pin cannot be passed into a tissue without opening into some of them. The arteries, even the smallest of them, are simply tubes for conducting the blood to its destination; but the capillaries are something more, for their walls are so thin that, though continuous, they permit fluid portions of the blood to ooze through to bathe the tissues that surround them. The blood in the capillaries is, therefore, in communication with the tissues surrounding them, and exchanges material with them even as it flows through them. At length the capillaries begin to join together to form larger and larger vessels, and so gradually veins are formed, at first microscopic in size, but gradually the blood passes into larger veins formed by the junction of smaller ones and by the addition of other coats, till the large veins of the particular limb or organ are reached. These join the veins coming from other limbs and organs, until the two large venous trunks are formed, the superior and inferior venæ cavæ, the one coming from the upper and the other from the lower parts of the body, which carry the blood to the right auricle. From the right auricle it passes to the right ventricle, then through the lungs by the pulmonary artery and its branches and back to the heart, but to the left side, by the pulmonary veins, as already described. By passing into the left ventricle the blood has completed its circuit of the body and lungs.

Thus blood which has issued from the left ventricle passes through two sets of capillaries before it returns to the left ventricle—the capillaries of the tissue which it is sent to nourish, and the capillaries of the lung. The blood which is sent to the stomach, bowels, spleen, and pancreas has, however, an unusually long circuit. After passing through the arteries of these organs, traversing their capillaries, and entering their veins, the blood reaches the portal vein, formed, as we have seen (p. 200), by the junction of the veins of the organs mentioned. The blood then passes through the capillaries of the portal vein in the liver and enters the hepatic vein, and so on to the inferior vena cava. Thus blood sent to the stomach and bowels, spleen and pancreas, traverses three sets of capillaries, those of the particular organ, stomach or spleen, &c., those of the portal system in the liver, and those of the lung. This is the longest route a portion of blood may take from the moment it leaves the left ventricle to the moment it returns to it. The shortest possible route is through the substance of the heart itself. A portion of blood entering the aorta, and immediately passing off by the coronary arteries (p. 302), will merely traverse the capillaries in the substance of the heart and return to the right auricle by the coronary vein, completing its circuit by passing through the lungs.

There are various things to notice connected with the flow of blood through arteries, veins, and capillaries, and associated with the differences in the structure of these vessels.

The Circulation in the Arteries.—It has been pointed out that the large arteries are specially elastic. The effect of this is not difficult to understand. Take the aorta as an example. It is filled with blood, but by the contraction of the ventricle an additional quantity is thrown into it. Sufficient room cannot at once be made by the onward flow of that which already occupies the vessel, and so part of the vessel distends sufficiently to accommodate it. As soon as the contraction of the ventricle is over, the force distending the artery is diminished, and, by their own elasticity, the walls of the vessel recoil, that is, they return to their natural degree of distension. In doing this the walls press on the blood contained by them, and tend to drive the blood both backwards and forwards. The blood is prevented passing backwards by the closure of the aortic valve, and it must all pass on into the next part of the artery, which in turn distends, being already full, to receive it. The same process is here repeated; the distended wall speedily recoils and passes the blood on to a succeeding part, which, also, first dilates and then recoils on the blood within it. Thus the contraction of the heart is not the only force in driving on the blood. It is aided by the elastic recoil of the arterial walls succeeding it, and the blood is forced onwards in waves.

The **Pulse** is thus explained. If a finger be laid on a part of the body where an artery approaches the surface a throbbing movement will be felt, and the finger, if lightly applied, or, better still, a piece of straw laid over the place, will rise and fall in a regular manner, and the beat, thus produced, will be perceptibly in time with the contraction of the heart. This movement is the result of the alternate distension of the vessel by the wave of blood, and the recoil of the walls by their elasticity. It does not occur at the same instant as the contraction of the ventricle, because it takes a little time for the wave to pass from the heart to the place where the pulse is felt, and it is, therefore, a little later at the ankle than at the wrist. Wherever an artery approaches the surface the pulse may be felt. The wrist is the most convenient place, but it is easily found at the temple and the inner side of the ankle. Various influences affecting the characters of the pulse are noted on p. 40.

The **jerky movement** of the blood in an artery is seen if the vessel be cut. The blood does not issue in a regular stream, but in spurts, corresponding to beats of the heart. This enables one to ascertain readily whether a wounded blood-vessel is an artery or a vein, for the flow of blood from the latter is *continuous*. This is of importance, because if an artery be cut we know the blood is flowing *from the heart* to the distant parts of the body. If the loss of blood is to be prevented, the vessel must be closed nearer to the heart than the wound, to prevent new supplies of blood coming on to the wound. This is done by pressing with the fingers or a pad on the heart side of the wound. If, on the contrary, it is a vein that is wounded, we know the blood is flowing in it *towards the heart* from the distant part, and pressure must be exerted on the side of the wound farthest from the heart.

While elasticity is the feature of the large arteries, the **contractility of small arteries** is their characteristic. If the muscular fibres which surround a vessel contract, the channel will be narrowed and less blood will be permitted to flow through it. If the muscular fibres relax, the force of the blood within the vessel—the **blood pressure** — will cause the channel to enlarge by dilating the tube, and more blood will be permitted to flow along. Thus the diameter of the vessel may be regulated by the muscular contraction, and the quantity of blood proceeding to a tissue or organ will be thereby affected. The contraction of the muscular fibres is controlled by the nervous system, and so the nervous system regulates and controls the blood supply to the various regions of the body. How this is effected is explained on p. 312.

Bleeding from small arteries that have been wounded is arrested, to a large extent, by the contraction of the muscular coats of the vessels. Tincture of steel and such substances, when applied to bleeding surfaces, stop the flow of blood because they excite the muscular fibres to contract, and so shut the mouths of the open vessels. It is for the same reason that tannic and gallic acids, &c., are ordered for bleeding from internal surfaces. To diminish and arrest internal bleeding a drug called ergot of rye, or spurred rye, is frequently used with excellent results. Now this drug does not act directly on the bleeding part, but it enters the blood and produces contraction of the muscular coat of the vessels. It arrests bleeding by stimulating the contractility of the smaller arteries.

The Circulation in the Capillaries must be considered next, since the blood flows from arteries into capillaries. The best way to observe the circulation in the capillaries is to fix up a living frog in such a way that the web of its foot is stretched so as to be viewed through a microscope. A fine transparent tissue is seen with clumps of black colouring matter here and there. The tissue is cut up by channels pervading it in all directions, some wide, some extremely narrow. Along these channels blood is streaming. In the wide vessels it is dashing along with apparently great speed, the red corpuscles streaming in crowds down the centre, while the white corpuscles are seen rolling along nearer to the walls of the vessel; in the narrowest vessels there is evidently room for only one corpuscle at a time, and the corpuscles range themselves along, accommodating their shape to the turns and corners so as not to stick in the channel. The noticeable feature is that the current is continuous. When it is remembered that the flow in the arteries is jerky, and that the capillaries are continuous with the arteries, this seems strange. Why is it that the jerking movement of the blood in the arteries is not continued into the capillaries? The explanation is found in the elasticity of the arteries. Were the blood-vessels rigid tubes, then there would be ejected from one end just the quantity of fluid forced in at the other, and in the same intermittent way. The blood encounters resistance in the capillaries, it cannot get along so quickly as in the arteries, the arteries are, therefore, kept constantly distended, and their elastic force is brought into full play. During the pause after each contraction of the heart the elastic walls of the arteries are pressing on the blood they contain, and are following up the force of the heart. It is as if there were two propelling forces, the one following the other so smoothly and regularly that there is no stoppage in the onward movement. If the elastic tube is long enough the result is that, by and by, the wave-like movement of the fluid in it becomes less and less perceptible, till it finally disappears, and the intermittent movement is converted into a continuous flow. It must be observed, however, that it is only where there is sufficient resistance to the progress of the fluid that this can happen, for if there is little resistance the elastic reaction is not brought into play, and the jerky movement continues. The next thing noticeable, connected with the capillaries, is the thin walls of the vessels, so that the oozing of fluid, already referred to, for purposes of nourishing the tissues, is easily understood. Another feature that one remarks is that every minute part of tissue is so surrounded with capillaries that it cannot fail to receive nourishment from all sides.

Generally speaking, every organ and tissue of the body abounds in capillary blood-vessels, even bone being interpenetrated by them. Tissues so traversed by vessels are said to be **vascular**. There are, however, a few tissues which are **non-vascular**, that is, they have no such system of vessels within them. These are epidermis and epithelium, in other words, the surface layer of the skin and mucous membrane; and nail, hair, the substance of the teeth, and cartilage or gristle. Such tissues, however, are closely connected with moist vascular tissues, from which they are able to suck up nourishment.

The Circulation in the Veins is characterized by a continuous flow, the wave-like movement having been completely lost in the capillaries. Besides the force from behind—the force that is transmitted through the capillaries from the arteries—other agents enter to impel the blood in its progress through veins. Chief of these are the valves which are present, with exceptions, in veins, and permit the flow of blood towards the heart, but close if there is any attempt at a backward flow. Contracting muscles, by pressing on veins, and, consequently, on the blood they contain, aid in the venous part of the circulation.

Besides the forces indicated in preceding paragraphs, the action of the heart, the elasticity of the arteries, the action of valves in the veins, and the effect of muscular contraction, there are others which aid in the circulation of the blood, and notably the movements of breathing, and the suction action produced by the relaxation of the heart after each contraction.

The Rapidity of the Circulation varies. It is quickest in the arteries and slowest in the capillaries. In the capillaries there is a much greater channel space, and since the quantity of blood entering the heart is always the same as that leaving it, the blood must flow more slowly in the capillaries if the balance is to be maintained. Thus from the aorta onwards to the capillaries the speed diminishes, and from the capillaries through the veins it increases to the heart. In the capillaries the rate is estimated as 1 to 1½ inches *in a minute*, and in one of the larger arteries 10 to 15 inches *in a second.* The length of time taken for a portion of blood to travel the whole round of the circulation is, in the horse, about half a minute. It has been estimated by injecting into one of the veins of the neck a substance—ferrocyanide of potassium—easily detected by chemical tests, and noting how long time elapsed before it was found in the blood of the same vein in the opposite side of the neck.

Nervous Control of the Circulation.—The walls of the blood-vessels are largely muscular. The muscular fibres are beyond the control of the will. Nevertheless they are controlled by the nervous system, by the agency of nerves distributed among the muscular fibres. The nerves are called **vasomotor** (*vasa*, vessels), and they are governed from a centre—the **vasomotor centre**—situated in the medulla oblongata (p. 150). The influence on the vessel may be briefly stated thus: By the nervous energy continually reaching the muscular walls they are kept in a moderate state of contraction or tone, so that the channels are maintained at an average size. If the vasomotor nerves are stimulated more than usual, the muscular walls contract more, the size of the channel is diminished the quantity of blood flowing through it is correspondingly diminished, and the supply to the part lessened. If the stimulus is less than usual, the amount of contraction is lessened, the vessels dilate by the force of blood within them, the channel becomes widened, and the supply to the part is increased. Now various influences from various parts of the body, or from the brain itself, may reach the vasomotor centre and excite it to increased activity; the nerves are thereby stimulated and the vessels contract. But there is another curious effect that may be produced on the centre, what is called an *inhibitory* or restraining effect, whereby the ordinary influence of the centre is, for a time, suspended, the tone of the vessels becomes diminished, and their channels immediately widen. The production of blushing and pallor is thereby explained.

Blushing is caused by some emotion which acts on the vasomotor centre and diminishes its activity. The tone of the vessels being lessened they dilate, more blood rushes along their channels, and the skin becomes redder and hotter by the increased quantity of blood. It is usually in the face that this is manifested.

Pallor is just the reverse condition. Some emotion so acts on the vasomotor centre as to increase its activity. The blood-vessels contract, less blood flows through them, and the part becomes pale. Thus the same emotion that causes redness of one person's face may produce paleness of another's.

More than this, the heart and the blood-vessels are related by nervous communication in a curious way. Connected with the heart there is a nerve called the **depressor** nerve. Suppose the blood-vessels in a considerable part of the body to be unduly contracted. Blood flows through them less easily, and the heart has more work in forcing it along. This may occur to such a degree that the heart is unnecessarily burdened. Its labour may become so heavy as to threaten fatigue, and danger of exhaustion may arise. At this period an influence passes from the heart by the depressor nerve to the vasomotor centre. The action of the centre is restrained, the tone of the vessels is diminished, by the pressure of blood within them they dilate, the blood flows along easily, and the heart is relieved. This is just an instance of how all the bodily functions are regulated and controlled by the nervous system, and made to serve the good of the whole body.

SECTION XV.

THE BLOOD, THE HEART, AND BLOOD-VESSELS.

(THE BLOOD-VASCULAR SYSTEM).

DISEASES AND INJURIES.

Diseases of the Blood:
- *Anæmia* (*Bloodlessness, Poverty of Blood*);
- *Plethora* (*Full-bloodedness*);
- *Leucocythæmia* (*White-cell Blood*);
- *Blood-Poisoning* (*Septicæmia, Pyæmia*);
- *Scurvy* (*Scorbutus*); *Purpura;*
- *Tendency to Bleeding* (*Hæmorrhagic Diathesis, Hæmophilia*);
- *Worms in the Blood* (*Filaria Sanguinis Hominis*)

Diseases of the Heart:
- *Inflammation of the Outer and Inner Lining Membranes* (*Pericarditis* and *Endocarditis*)—*Valve Disease;*
- *Overgrowth* (*Hypertrophy*), *Wasting* (*Atrophy*), and *Degeneration*—Fatty Degeneration;
- *Palpitation* and *Fainting* (*Syncope*);
- *Angina Pectoris* (*Breast-pang*)—Neuralgia of the Heart;
- *Cyanosis* (*Blue Disease*).

Diseases of the Arteries:
- *Inflammation* and *Degeneration of Arteries, Aneurism;*
- *Thrombosis* and *Embolism;*
- *Wounds.*

Diseases of Veins and Capillaries:
- *Inflammation of Veins* (*Phlebitis*); *Varicose Veins;*
- *Blood-vessel Tumours* (*Angeioma, Nævus,* or *Mothers' Mark*);

Inflammation:
- Its Characters, Causes, Results, Symptoms, and General Treatment.

DISEASES OF THE BLOOD.

(Refer to Plates III., IV., V., and XXX.)

In the immediately preceding section an effort has been made to emphasize the fact that the condition of the blood is affected in two ways: (1) by what is added to it, and (2) by what is taken from it. It has been pointed out that additions to it consist in what it receives from the alimentary canal in the shape of food, what it receives in the shape of lymph, what it receives in its course through the body from the tissues with which it comes in contact, and what it receives from the lungs in the shape of oxygen gas, not only nourishing substances, that is to say, but waste substances also; and that substances are removed from it by the tissues for their nourishment, and by the lungs, liver and bowels, kidney and skin, to be cast out as waste matters. The importance of recalling these facts consists in this, that the causes of diseased conditions of the blood may be classed under two similar general divisions. For disease may be occasioned in the blood (1) by the nature of the food, by the lymph (by the absorption, for instance, of poisonous material from a wound, see p. 279), by substances picked up in the progress of the blood through diseased tissues, and by gases, &c., inhaled by the lungs; or (2), from the other side, by the lungs, kidneys, liver, bowels, or skin failing to separate waste matters, which are thus allowed to accumulate in the blood and impair its quality. The same thing is expressed, in a still more general way, by saying that disease of the blood may be due to something affecting (1) its quantity, and (2) its quality. Thus there may be too little blood in the body, in which case there arises the condition of bloodlessness (*anæmia*) or poverty of blood, or there may be too much blood in the body (*plethora*), full-bloodedness; while, again, the blood may be sufficient in amount but of bad quality, as it is in scurvy and other diseases. These considerations will be best understood by those who have carefully studied the description of the blood and its functions given in preceding pages.

We shall first consider the two diseases that have been named as connected specially with the quantity of blood, and afterwards those in which quality is directly affected.

Anæmia (*Bloodlessness, Poverty of Blood*).—The word anæmia is exactly translated by bloodlessness. It is derived from two Greek words, *an*, want of, and *haima*, the blood. It essentially consists in a deficiency of blood, and specially of certain of its constituents, the corpuscles and albuminous elements. So marked is the diminution in the number of corpuscles in typical cases that it may be recognized in a drop viewed under the microscope. (See Plate IV.) One form of it is specially a disease of young women, and is called **chlorosis** (Greek, *chloros*, green) or **green-sickness**, because of the peculiar hue of the skin produced by it.

The condition may be produced by loss of blood, in young women, for example, by excessive discharge during the monthly periods, or in persons subject to bleeding piles, by bad or insufficient diet, and by other diseases, such as cancer, tubercular disease, and syphilis, and by various other causes not well understood.

Its **symptoms** are paleness of the skin—the pallor being strikingly marked in those parts which are naturally ruddy, such as the lips,—weakness, attacks of faintness and breathlessness, palpitation, giddiness, loss of appetite, flatulence and indigestion, quick weak pulse, and nervous symptoms, such as lowness of spirits, listlessness, irritability of temper, neuralgia, &c. In girls hysterical attacks are common. Two noticeable symptoms are headache and impairment of sight.

Treatment, except in pernicious forms of the disease, is usually successful. It consists in arresting any unusual loss of blood, in the use of proper and sufficient food, and in attention to other ordinary conditions of health, good air, exercise, sleep, &c. The principal drug given in the disease is iron. This may be given in the ordinary way with quinine, as quinine and iron tonic, or in pill combined with phosphorus and nux vomica (see p. 169). Chemical food may also be used, and other similar preparations, beef and iron wine, &c. A valuable preparation is that of dialysed iron, of which 10 to 15 drops are taken in water four or five times daily.

Most iron preparations blacken the teeth, and they should therefore, be taken through a straw, or in pill or tabloid, and the mouth well rinsed afterwards.

Pernicious Anæmia (see Plate IV.) is a term applied to a form of anæmia distinguished by its progressive and very fatal character. The persons who suffer from it complain of great muscular weakness, of giddiness, palpitation, breathlessness, loss of appetite, constipation. The patient's skin usually is intensely pale, and even death-like in advanced cases. There is also a degree of puffiness of the skin, and the patient does not lose, as in most exhausting diseases, the layer of fat under the skin. Owing to the two last-mentioned facts, therefore, patients, specially young girls, have an appearance of being well-nourished, if not over-fat, which contrasts strangely with the pallor and the complaint of weakness and easy exhaustion. There is a constant tendency to rupture of the smaller blood-vessels, specially in tissues of loose texture where the vessels are ill-supported, such as the brain and other parts of the nervous system, and the retina of the eye.

The examination of the blood according to the method described in the introduction (p. 18) at once enables one to distinguish between this form of anæmia and the simple kind, for the differences in the characters of the blood in the two types of anæmia are very great. They are shown in Plate IV., and noted on p. 21.

The causes of the pernicious type are not yet certainly known, but there is some reason for believing that it is due to the action of a poison —toxin—produced by organisms, and that such toxins may be produced in the mouth by the rotting stumps of teeth, or in the stomach or bowels by certain ulcerative and other conditions. The state of mouth, stomach, and bowels ought, therefore, always to be investigated, and specially should the possibility of tape-worm in the bowel be carefully considered.

In the **treatment**, when the state of mouth, stomach, &c., has been noted, and any disorders, errors in diet, &c., corrected, arsenic is the drug mainly relied on.

Plethora (*Full-bloodedness*) is the opposite condition to anæmia. It is also called **hyperæmia**, from Greek, *huper*, signifying excess, and *haima*, the blood. The blood contains excess of red corpuscles, is, in short, over-rich.

Symptoms.—Full-blooded people are easily recognized by their florid colour and stoutness. They are usually troubled with giddiness, because of excessive quantity of blood in the head. The pulse is full and strong. The veins of the surface of the body are visibly distended. The capillary blood-vessels are in a similar condition, and there is, therefore, a tendency to bleeding, apoplexy, &c. There are laziness and listlessness, a sense of restriction, a dull condition of mind, and tendency to sleep. The liver is usually sluggish, and the results of that condition are apt to arise (see p. 270). Plethoric people are commonly addicted to indulgence of the appetite in eating and drinking.

The **treatment** is clearly indicated. It consists in plain and temperate living, and avoidance of rich and fatty foods, of beer, wines, and spirits. Besides this, active measures should be employed to reduce the condition, vigorous exercise, and the frequent use of medicine to unload the liver and bowels. The best medicines for this are saline purges, epsom and seidlitz salts taken early in the morning, or some of the mineral waters. It is in full-blooded persons that, in threatened attacks of apoplexy or in feverish and inflammatory conditions, congestion of lungs, &c., bleeding proves specially relieving.

Leucocythæmia (*Leukæmia — White-celled Blood*) is derived from Greek words, *leucos*, white, *kutos*, a cell, and *haima*, the blood, and literally means white-celled blood. This indicates the chief feature of the disease, which is an excessive production of the white corpuscles of the blood. These should exist in the blood in the proportion of 1 to every 600–1200 red ones; but in this disease they may come to equal or exceed the red corpuscles in number. Accompanying the chief feature is enlargement of the spleen, which, from being as a rule less than half a pound in weight, may come to weigh many pounds. Enlargement of the lymphatic glands and affection of the marrow of bones are also common during the progress of the disorder. The excessive number of the white corpuscles, and the enlargement of the spleen and lymphatic tissues, are associated, such tissues being supposed to have to do with the manufacture of the white corpuscles. The causes of the disease are not known, though in a considerable number of cases exposure to marsh poison has been connected with it. Men are more liable to it than women, and between the ages of twenty and fifty. (See Plate V.)

The chief **symptom** is the great increase in the number of white corpuscles, which can only be ascertained by microscopic examination of the blood. As one would naturally expect, the diminution of the coloured corpuscles affects the colour of the blood, so that the person becomes pale. The enlargement of the spleen reveals itself by fulness of the belly, and, when it is considerable, the person is himself able to detect the presence of a large solid heavy mass extending downwards on the left side from under the ribs towards the groin. It is unaccompanied with pain. Increasing weakness and shortness of breath are marked. Bleeding is not uncommon, especially from the nose, but it may cause death by occurring in the brain, or it may be in the nervous coat of the eye affecting sight. Feverish attacks, dropsy, and other symptoms may also be present. Death occurs within a year or two, either from weakness or because of bleeding or other complication.

Treatment is directed towards maintaining the patient's strength by food, fresh air, and tonics like quinine and iron, and phosphorus.

Blood-poisoning (*Septicæmia*, from Greek, *sepo*, to putrefy, and *haima*, the blood; *Pyæmia*, Greek, *puon*, pus, matter, and *haima*, the blood) is a disease due to the introduction into the blood of poisonous materials of a particular kind. The poison is produced by minute living things always found in abundance in the matter of unhealthy sores. (See CONTAGION, p. 493.) It is commonly in cases where such wounds or raw surfaces exist that the disease arises. Thus it is attendant on surgical operations; its occurrence is feared in cases of accident where injuries of any extent have resulted; it is frequently the cause of death in cases of dissection wounds, carbuncle, erysipelas, and in suppurations involving bone, &c.; and it is one of the most terrible and fatal occurrences after childbirth. (See PUERPERAL FEVER.) To take the last case, the separation of the after-birth (placenta) leaves a large raw surface in the interior of the womb. If the after-birth has not been completely removed, and if a small piece remains attached, it begins to decompose and break down. This is nature's way of getting rid of it. But this decomposition is attended with the formation of unhealthy material, which easily gains entrance to the blood, and produces the symptoms of the disease. The septic or poisonous matter seems to be formed at the wound and to be absorbed, and, as has been said, the septic material is the product of certain minute living things (bacteria, p. 495) found in a womb in such a condition. The word **pyæmia**, which literally means pus (matter) in the blood, is often used to signify the same condition. It means rather more. The poison of septicæmia is of a very subtle kind, not visible even with the highest microscopes, but in pyæmia there is an actual transference along the blood-vessels throughout the body of minute pellets of poisonous material, which come from the place where the unhealthy action is going on. These pellets, carried along in the current of the circulating blood, easily pass through the large arteries, but when they reach the very minute arteries they cannot pass along them. These arteries, therefore, become blocked by the poisonous material, and abscesses form wherever this occurs. Now the pellets are distributed to every organ of the body, to lungs, liver, kidney, brain, &c., in all which situations spots of inflammation and abscess arise. How serious such complications are may be imagined.

Symptoms.—The first occurrence usually is a fit of shivering, lasting for some time and followed by severe sweating, after which the person seems to get better; but another prolonged shivering occurs, followed again by sweating, and so on. The fever runs very high, diminishes considerably after the sweating, but after a few days usually keeps high. The patient after a day or two begins to have a sallow look, and to be dull and heavy. The pulse is quick and weak, the tongue brown and dry, and the lips parched. Vomiting occurs, and perhaps looseness of bowels, and what is passed is dark and very badly smelling. The breathing is quick and shallow, cough often arises, and pain and tenderness of the belly may be present. In severe cases of pyæmia little patches of inflammation and suppuration may be seen on the fingers or toes or on various parts of the surface of the body. The occurrence of delirium of the muttering sort is a very grave sign. In the beginning of it the person's hands wander aimlessly about, picking at the bed-clothes, and it passes into unconsciousness as death approaches.

A chart showing the behaviour of the fever is shown in Plate XXVI.

Treatment is in very many cases of little avail. The main thing is to keep up the person's strength by nourishing food in fluid form, concentrated soups, beef-tea, milk, &c., and stimulants in small quantities repeated as often as seems desirable. At the beginning a good dose of saline medicine seems to relieve —seidlitz powder for example. To diminish, if possible, the fever, 5 to 10 grain doses of quinine should be given every six hours. Opium is often used to relieve pain and other symptoms, but it is a drug whose administration should be controlled by a medical man.

Any unhealthy wound, &c., should receive attention, as it may be the source of the disease. Indeed anyone suffering from a wound, erysipelas, inflammation of bone, &c., seized with shivering and sweating, should lose no time in summoning a doctor.

It is of the utmost importance to observe that the poison of septicæmia and pyæmia may be carried from one person to another, especially in the hands, &c. Therefore the patient should be kept strictly clean, in a well-ventilated room; all discharges, as well as clothes, &c., stained with them, should be disinfected by a solution of chloride of lime, and the attendant's hands should be frequently washed in Condy's fluid and with carbolic soap.

Scurvy (*Scorbutus*) is a disease due to an altered condition of blood produced by the absence from the food of certain ingredients it ought to possess. What the exact ingredients are it is not easy to say. Sailors deprived of a proper quantity of vegetables in their diet, and living too exclusively on salt meat, are easy victims to the disease. It is not limited to sailors, however, for a scurvy condition may arise on land among ill-fed persons in times of want, and it has broken out among armies in the field. (Refer to VITAMINES, Vol. II., p. 141).

Its **symptoms** are a pale, sallow, or muddy complexion, disinclination to exertion, and lowness of spirits. There are rheumatic pains in the back and limbs. The appetite is not affected, but the bowels are bound. The tongue is large and flabby. In fact these preliminary symptoms are similar to those of anæmia, already described. Characteristic signs of the disease soon appear, such as reddish-brown spots on the skin, first of the legs, then on the rest of the body. They are like flea-bites, and are, indeed, produced by the escape of small quantities of blood from small vessels. **Petechiæ** is the term applied to them. Blood may escape in large quantity, and give the appearances of a discoloration due to bruises. Puffy swellings also occur, specially about the elbows, knees, lower parts of the leg, the angles of the jaws, and about the eyes. The gums swell, become spongy, deep-red in colour, and are easily made to bleed and ulcerate. The breath smells very foul, and the teeth become loose in their sockets. Great muscular weakness, faintish attacks, dropsy, looseness of bowels, delirium, &c., occur in advanced stages of the disease. Death arises from exhaustion or loss of blood.

The treatment, if well directed, may restore persons apparently hopeless, and that with considerable rapidity. It consists in supplying to the food the ingredients that have been absent from it. This is done by the use of fresh vegetables, potatoes, carrots, turnips, green vegetables, oranges, lemons, &c. Lime-juice also is a valuable restorative. One or other of these kinds of food must be added in considerable quantity to a diet otherwise nourishing. Meanwhile the person must rest for a time till danger of fainting or attacks of bleeding has passed away. The English Board of Trade now compels emigrant ships to carry a certain quantity of vegetable diet for each person, and sufficient lime-juice to supply 3 ounces weekly to each person. Merchant ships are also required to carry lime-juice for the crews, each man to receive 2 ounces weekly, and more if signs of scurvy appear.

Purpura is attended with escape of blood beneath the skin and mucous membranes, and is, like scurvy, due to a bad condition of blood. It may occur at any age, but it occurs specially among young children, and not only the badly-fed but the healthy-looking may be attacked.

The **symptom** because of which the disease is named is the occurrence of spots in the skin of a deep-red colour, from mere points in size up to circular spots one-fourth of an inch across. The spots do not fade when pressed, and are not raised above the skin. The colour, at first deep-red, fades and becomes bluish, yellowish, and finally disappears just as the blue marks of a bruise fade. They occur usually on the legs. In severe cases large bleedings may occur not only under the skin but in the mucous membrane of mouth, nose, stomach and bowels, bladder, womb, &c.; and the loss of blood thus occasioned may be so great as to produce great pallor, headache, fainting. The disease may occur suddenly among the apparently healthy, but it also frequently declares itself after preliminary symptoms of headache, weakness, and languor, loss of appetite, and rheumatic-like pains in the limbs, lasting one or more weeks.

Treatment is in some cases very simple; good food, quietness, and rest being all that is required to complete recovery in a week or two. What medicines are best in severer cases is not certain. Tonic treatment, however, it ought to be. Quinine and iron may be used, or quinine (2 grains for each dose) with dilute hydrochloric acid (10–15 drops) taken in water three or four times a day. Arsenic is also used, but it should not be employed without medical advice. Attacks of purpura may return. Therefore attention should be given to the diet, which should be of a mixed kind, with, that is, both vegetable and animal food.

Tendency to Bleeding (*Hæmorrhagic Tendency, Hæmophilia*).—This is an inherited condition in which bleeding, very difficult to stop, is apt to occur for very slight reasons. It is handed down chiefly by the females of a family, but is manifested specially by the males. Families in which the tendency is exhibited are called "**bleeders.**"

The bleeding may occur from any part of the body—nose, throat, lungs, stomach and bowels, bladder, &c., as well as into the skin. It may be provoked by a pin-scratch, a leech-bite, extraction of a tooth, &c. Bloodlessness may be a consequence of repeated attacks. Painful swellings of the larger joints are also liable to trouble persons affected with the tendency. Death may be occasioned by bleeding into the brain.

Treatment consists in taking care to avoid any occasion of exciting an attack, caution against accidents, injuries, &c. If bleeding arise it must be stopped, if possible, by means of pressure on the part, or where the part cannot be reached, by the use of such remedies as are ordered for bleeding from the stomach (p. 237), bleeding from the lungs, &c.

Worms in the Blood (*Filaria Sanguinis Hominis*).—Some years ago (1870) a worm of microscopic size was found in the blood of persons suffering from a disease called **chyluria**, in which the urine is milky, due to the presence of chyle (p. 276) in it. Researches made by various observers since then have shown the presence of such parasites in a considerable number of cases. They seem to exist specially in the lymphatic vessels, which may become blocked by them or their eggs, swelling and overgrowth of the part below the place of obstruction resulting, the swelling being independent of inflammation. From the lymphatic vessels the worm, which is of the thread class, may find its way into the blood, and so be distributed throughout the body. It is in tropical countries that the disease occurs. The parasites may exist in large numbers without producing symptoms of their presence. There is no treatment for their destruction known.

DISEASES OF THE HEART.

"Heart Disease" is a term which conveys a very serious meaning to most persons. Apart, however, from the fatal termination it is commonly held to indicate it implies nothing definite to the popular mind. It is indeed a very vague phrase, for, as we shall see, heart disease may exist in a great variety of forms, some of which are not nearly so serious as others. Either the double bag (*pericardium*) which envelops the heart, or the heart substance itself, or its valves, may be the seat of disease; and the general term "heart disease" includes unusual conditions in any of these. It will be necessary, therefore, to consider the principal affections of the pericardium, of the heart substance, and of the valves.

INFLAMMATION OF THE OUTER AND INNER LINING MEMBRANE: VALVE DISEASE.

Inflammation of the Pericardium (*Pericarditis*).—The position and character of the outer lining membrane of the heart have been briefly noted on p. 298. It has been pointed out that it is in a double layer, the layer in direct contact with the heart being separated by a slight interval from the outer layer, a small amount of serous fluid existing in the space. Now when the membrane becomes inflamed the blood-vessels enlarge, becoming more full of blood, in consequence of which thickening of the membrane takes place. There oozes from the vessels on to the free surfaces of the membrane a fluid which coagulates—lymph; and thus the surfaces which oppose one another, instead of being smooth and glistening, become irregular and roughened because of the newly-formed deposit. The two layers ought to glide easily and noiselessly over one another with the movements of the heart, but, owing to the roughening, friction is produced, and a grating sound may be heard on applying the ear to the chest over the heart. Part of the fluid from the over-full vessels is not coagulable—serum; and it collects in the space between the two layers. It may become so abundant as to separate the layers completely from one another, in which case, of course, friction ceases. In some cases its quantity is so great that the heart is actually surrounded by a bag of fluid, giving rise to what might be called **dropsy** of the heart. If the inflammation abates at this stage, the vessels of the inflamed membrane begin to recover their usual size, fluid ceases to escape from them, and then a process of recovery sets in, in which the fluid begins to be absorbed by vessels—both blood-vessels and lymphatic vessels. The quantity of fluid surrounding the heart slowly diminishes till again the layers come into contact, friction is again produced, and the sound of it again heard. Finally the roughened surfaces adhere and become firmly connected to one another, so that they become fused and a space between them no longer exists.

This is a species of cure, there is no doubt, but the adhesion of the layers of the pericardium is too apt to lead to the development of disordered conditions of the heart at a later stage of the person's life.

Instead of taking a simple course like this, the disease may be complicated by the formation of matter in the sac of the pericardium, and may continue in a chronic form for a longer period than the acute attack lasts.

The **cause** of the disease may be simply exposure to cold, or injury such as a wound would readily produce, or it may be due to the extension of inflammation from some other organ, like the lungs. Frequently, moreover, it occurs as a complication in other diseases, specially acute rheumatic fever, disease of the kidneys, St. Vitus' dance, scarlet fever, pyæmia, &c. In a case of rheumatic fever the inflammation usually does not only affect the outer lining membrane of the heart, but the inner as well.

Symptoms.—There are pain and tenderness in the region of the heart, and extending from that part to the left shoulder and down the left arm. Fever is also present, with loss of appetite and dry tongue. The patient wears a peculiar look of distress, has a dry cough, and a catch in the breath. The pulse is at first full and strong, but later quick and weak. When much fluid has accumulated in the sac the pressure it exerts on the gullet behind may produce difficulty of swallowing. Rambling and delirium are occasionally present.

Death may result from the pressure of the accumulated fluid surrounding the heart—from the dropsy,—the heart being unable to continue its work under the burden; and then it is sudden. Recovery in severe cases is usually slow, and the difficulty of breathing, quick pulse, &c., disappear very gradually.

Besides these symptoms there are others whose value and meaning are only appreciated by those who have had a medical education. One is the friction sound, already alluded to, heard by applying the ear to the chest over the region of the heart, or by listening with a stethoscope, the instrument used for sounding lungs and heart. It is due to the rubbing of the inflamed surfaces of the membrane on one another. Other signs are obtained by percussion, as described on p. 359. The percussion is performed on the chest, a clear, hollow sound being obtained when the chest is percussed over the lungs, the sound being dull when the tapping is over the heart. The area indicated on Fig. 133, p. 297, as occupied by the heart will give out a dull sound; but where the pericardium is filled with fluid it will be caused to bulge out by its contents, and the limits of dulness will thus become much more extensive, because the sac filled with fluid will give out a dull, dead sound. In this way a trained person may discover whether much or little fluid has been poured out by the inflamed membrane.

Treatment.—If the inflammation arise as a consequence of another disease, that other disease must be treated. The special treatment directed to the heart may take the form of bleeding by placing several leeches on the chest. This, of course, would only be adopted by medical advice, and it would be applied only in acute attacks of otherwise strong persons. Blisters over the heart, iodine paint, and poultices, &c., are also employed. Stimulants are required if weakness is great and there is a tendency to faintness. Other drugs are also useful to relieve pain, or to diminish the action of the heart, but they are dangerous except in skilled hands.

Diseases of the Valves of the Heart.—The inner lining membrane of the heart (endocardium, see p. 298) is even more liable to inflammatory affections than the pericardium, and the term **endocarditis** is the scientific term applied to them. It is, however, usually the valves that specially suffer (as we have seen, p. 299, they are formed partly by folds of the endocardium), and on this account we shall consider the affections under the special heading DISEASES OF THE VALVES.

The nature of the disorder is also akin to that which affects the outer lining membrane. The blood-vessels of the valves are congested and the substance of the valves becomes thickened. Coagulable material is also deposited on them; and warty growths form in consequence. The results of this are various. The thickening and growths on the valves prevent their free play, and hinder the due performance of their all-important duties. Moreover, they become puckered and contracted, so that they are no longer able completely to close the passage which it is their business to guard. They may also become so rigid and unyielding as to offer a permanent obstruction to the free passage of the blood in the direction in which they ought to be freely open. Standing out at an angle from the wall of the passage, and refusing to bend from this position, they bar to a greater or less extent the flow of blood past them. This rigid attitude may be the result, not only of inflammatory thickening, but also of the deposit, within the substance of the valves, of chalky matter, which makes them hard and inelastic, a condition apt to arise in old age and to affect not only the valves but also the walls of the arteries throughout the body. Now what must be the effect of such states as these? It can only be properly understood by reference to the functions of the valves, as already described on p. 299. Take the left side of the heart, for it is in the valves of the left side that the disorder is commonest. We have seen that there are, on this side, two valves. There is the mitral valve between the upper and lower chambers, which is open on the contraction of the upper chamber to permit the blood to be driven into the lower, and which, as soon as the lower chamber contracts, closes to bar the return of blood to the upper chamber. Suppose, first, that this valve has become contracted and too small properly to close the passage. Then it is plain that when the lower chamber contracts, the communication between it and the upper one not being completely cut off, all the blood is not driven into the vessel (aorta) that rises from the ventricle (the lower chamber), but part passes back again into the auricle, which thus becomes overfull because it receives back part of the blood which it had, but an instant before, sent onwards. Suppose, again, that the valve is standing out rigidly in the fair way, then, when the auricle contracts, the blood is obstructed in its passage downwards to the ventricle, and it is hard work for the auricle to get itself thoroughly and quickly emptied. The second valve on the left side is at the place of communication between the ventricle and the great artery springing from it—the aorta,—and when the ventricle contracts, the blood should be propelled into the artery, and the valve should thereafter close to prevent it returning again to the chamber (see p. 300). If the valve is incompetent, that is, if it does not properly close the opening, when the ventricle is relaxing the valve does not completely hinder the blood returning, and part of it pours back to the ventricle. Thus it is never properly and satisfactorily emptied. **Regurgitation** is the term applied to the return of blood in this way. If, again, the valve be rigidly standing out from the wall of the aorta, the blood driven out of the ventricle does not find a free passage, it is delayed in its exit, and the heart has to contract more vigorously to overcome the resistance.

Any of these disturbances of the circulation through the heart cannot exist without changes being produced in the heart itself. Whether it be that there is an obstacle to the flow of blood through the heart, or that part of the blood that should pass onwards returns, the first effect on the heart, and specially the chamber first affected, is that it begins to enlarge. This is partly because it works harder to perform its task, which has become more difficult, increase of growth occurring to meet the increased demand for energy, and partly because the increased quantity of blood, always in it, produces a distension of the walls to afford increased accommodation. The heart enlarges in its substance, that is, it suffers **hypertrophy** (overgrowth), and it also suffers **dilatation** (overdistension). But the changes are not limited to the heart; they in time affect the whole body. If the ventricle becomes overfull, because of disease of the valves of the aorta, that will speedily produce a similar condition of the upper chamber, the pressure passing backwards. Since the auricle receives its blood from the lungs (p. 309), and since the blood does not get passing onwards quickly enough, the lungs will, by and by, begin to feel the backward pressure, and become more or less blocked with blood also. Since the lungs receive the blood from the right side of the heart, the pressure will travel backwards to the chambers on that side, and they in turn will become overfull. Moreover, the blood arriving in the right side of the heart comes from the head and neck, some of it directly from the liver and also from the trunk and lower part of the body, and that coming from the liver is the blood from the stomach and bowels, &c. The blocking will, therefore, travel ever backwards and backwards to these organs, so that the veins of head and neck, liver, stomach, &c., will become congested. Just as, if you have a large number of streets and lanes opening into a main thoroughfare, along which crowds of people are streaming, if one end of the main thoroughfare becomes partly blocked and the crowds still stream on, that thoroughfare will speedily become blocked from one end to the other, and then the lanes and adjoining streets will in turn become crowded with the people who cannot get on. Of course if the people could be made to pass off some other way the blocking would soon be got rid of; but the blood must all go on in the destined course, there is no side way by which it can escape, and as time goes on the congestion becomes worse and worse. Another thing to note is that while the veins bringing the blood to the heart all become unduly full, the arteries do not contain sufficient blood, because the blood is not escaping in a full enough stream from the left side of the heart, and thus the various organs cease to be duly nourished, while at the same time they are congested with blood. Thus it becomes clear how, from valvular disease of the heart, congestion of the lungs, liver, kidneys, stomach and bowels, brain, &c., arises, and how consequently shortness and difficulty of breathing, with an attendant livid hue of the skin, jaundice, indigestion, kidney disease, headache, giddiness, convulsions, &c., may be occasioned. Moreover, fluid oozes out of the overcharged veins and dropsies arise. Meanwhile the heart itself suffers from defective nourishment, and its labour becomes too great for its strength. It becomes weakened, and with its commencing failure the consequences of its disease are at once aggravated.

Now, while such is a sketch of the consequences of an aggravated case of valvular disease, it is not to be supposed that all cases of valve disease run a similar course. Such is very far from the truth. There is no manner of doubt that many people have some imperfection of the valves of the heart and never become aware of it, but are able to lead active lives without being aware of any symptom that leads them or others to suspect any unusual condition of the heart. An average length and an ordinary vigour of life are not inconsistent with some forms of valvular disease. That is why doctors frequently refrain from informing patients of such a condition they may know to exist there. For heart disease is a phrase of terror to many, and the knowledge that they were, in even the smallest sense, subjects of it would seriously affect their lives, while they might live long and useful lives in blissful ignorance, and die, perhaps, of some disease entirely unconnected with disorder of the heart.

Further, though sudden death is a result of some forms of disease of the valves, it is not so common as was at one time supposed.

Another result of affection of the valves remains to be mentioned. The roughened condition of the valves sometimes causes fibrin to be separated from the blood, and to be deposited in little clots on their edges. The clots may become detached and swept away in the current of blood. They pass easily through the larger vessels, but at last reach vessels too small to permit their passage, which they block up. This blocking of small vessels by detached clots is called **embolism**, and is referred to on p. 326. Sudden death is a common result of this, a clot finding its way to the brain, and blocking a vessel, cuts off the blood supply to a part of the brain, and sudden paralysis or unconsciousness is the result.

The **causes** of the disease are acute rheumatic fever in particular, St. Vitus' dance, scarlet fever, Bright's disease of the kidneys, syphilis, &c.

Symptoms.—General symptoms have already been indicated in the sketch given of the results, affections of the lungs, congestion, bronchitis, &c., with attendant lividness of the skin, difficulty of breathing, jaundice, indigestion, disease of the kidneys, with scanty, high-coloured urine, and nervous symptoms, headache, giddiness, &c. Connected with the heart itself there are things to be noted. The beat may be feeble or excessive, and it may be irregular. **Palpitation**—frequent, sudden, and violent beating of the heart is common. But it must not be forgotten that palpitation, irregularity of the heart's beat, and a form of irregularity, called intermission, in which a beat is missed and the person feels a throb or tremble or fluttering sensation, perhaps with a feeling of choking, are far more commonly due to indigestion, specially indigestion with flatulence, than to heart disease. Many people, particularly women, are convinced they suffer from heart disease because of palpitation and the very uncomfortable sensations it produces, when all the time there is nothing but a stomach derangement to blame.

The special signs of disease of the valves of the heart, whose discovery alone justifies one in declaring the disease to exist, are such as a person cannot easily detect in himself. They are found by an examination of the chest, and by listening to the sounds produced by the contracting heart. A physician will find at what part of the wall of the chest the heart beat is felt most distinctly, and will see whether it is in the right position; he will examine by percussion—by tapping the chest as indicated on p. 319—to determine whether the heart is the usual size or is enlarged; and he will employ auscultation—that is, he will listen with his ear to the chest wall or by means of the stethoscope—to hear the sounds of the heart, in order to learn if they are of the usual character. For the sounds noted on p. 303 will be altered if disease of the valves be present. If a valve be diseased, one of the sounds will be replaced or attended by a blowing murmur, and the relation in point of time which the murmur bears to the heart sounds will indicate which valve is affected. A skilful man will exercise caution, because a temporary murmur may be produced by pressure or other circumstances, bloodlessness of the patient, for example, which might without care be mistaken for the sound of a diseased valve. In rare cases the peculiar sound has been loud enough to be heard by the patient himself and those standing near him; commonly it requires to be examined for.

The **treatment** of valve disease depends on various circumstances. If it is a complication of some other disease, rheumatism, &c., clearly that other disease requires attention. A person who has had rheumatism should exercise great care to avoid cold, draughts, wettings, &c., that would readily excite a second attack. General treatment of the disease consists in avoidance of all excitement—running, hurrying for trains, jumping, mounting long stairs, in fact everything involving exertion. Fits of anger, outbursts of emotion, &c., should equally be avoided. The bodily health should be carefully maintained by judicious eating and drinking, and over-eating, the excessive use of tea, tobacco, and stimulants, &c., should be rigorously guarded against. The health may be benefited by change of air, iron tonics, &c. If distressing symptoms, such as palpitation, difficulty of breathing, &c., arise, they will be much relieved by complete rest. Drugs, and in particular digitalis, are used to strengthen and calm the heart, but how and when they should be used ought to be determined by a medical attendant.

A most successful method of treating some heart affections, including recent valve disease in the young, is by Nauheim baths (see p. 487, Vol. II.).

OVERGROWTH, ATROPHY, AND DEGENERATION.

Overgrowth (*Hypertrophy*) and **Dilatation** of the heart have been noted as results of valve disease. But either may occur independently of any valve disease, and is then spoken of as simple hypertrophy and simple dilatation, and the two may be combined.

Simple hypertrophy occurs as a result of excessive stimulation of the heart, for instance, excessive exercise. It is thus not infrequent in athletes, by over-exertion in swimming, and specially by swimming under water and excessive diving. Simple hypertrophy may also occur as the result of excessive smoking, and then the heart becomes tumultuous in its beat. The treatment of such cases is by rest and avoidance of the excess.

Simple dilatation may follow overstrain, and is common when the heart muscle is weakened by, for example, the poison of influenza. I am persuaded that dilatation is very often produced in the young and immature by prolonged bicycle-rides, specially if there is much uphill work or running against the wind. It is probably invariable in prolonged cases of anæmia. For such cases tonic and iron treatment is best, and nothing produces so remarkable results as the Nauheim treatment (p. 487, Vol. II.).

Atrophy of the heart is the opposite of overgrowth, and is a consequence of wasting diseases, such as consumption, diabetes, &c. In it the action of the heart is feeble, and the beat against the chest wall weak. The treatment is that of the bodily condition of which it is a consequence.

Fatty Degeneration of the heart is a condition of advanced life, and is produced also by acute fevers and by poisoning with phosphorus. It is also a frequent result of such inflammation as has been described under INFLAMMATION OF THE PERICARDIUM, p. 318.

In fatty degeneration the muscular fibres of the heart substance are affected. The proper substance of the fibres is replaced by oily particles, and the muscular tissue is in consequence weaker and more easily torn. The degeneration is usually in patches in certain parts of the heart's substance; these parts are weaker than others. Fatty degeneration is a cause of sudden death. The soft fibres readily give way under some strain, even though it be slight, the excitement of some sudden emotion, and a tear occurs in the substance of the heart, through which the blood passes into the surrounding pericardial sac. Thus fatty degeneration is one cause of **rupture of the heart**; and the phrase "a broken heart" contains a literal truth.

The **symptoms** are those of feebleness of the heart. The pulse is weak, and the heart-sounds feeble. There is general weakness, a tendency to breathlessness, giddiness, and faintness.

The symptoms of rupture of the heart are sudden severe pain about the heart, gasping for breath, fainting, and speedy, in many cases instantaneous, death.

The **treatment** of such a condition as fatty degeneration is simply such as will maintain the strength of the person as much as possible. A very moderate, carefully adjusted diet (poor in fats, sweets, and starches), gentle exercise, fresh air, &c., are demanded, as well as iron and similar tonics. It is plain that all excitement, worry, &c., must be avoided.

It may be noted that rupture of the heart may be produced by external violence, and that immediate death even from a wound is not invariable. The wound may be blocked by blood clot, &c., and death be delayed.

PALPITATION AND FAINTING.

Palpitation has already been commented on (p. 321). It includes irregular action of the heart of various forms, which produces uncomfortable sensations of fluttering at the heart, throbbing, and tumbling, and is attended by other feelings of anxiety or distress, of difficult breathing, of giddiness and faintness, and so on. Motes may be seen dancing before the eyes, the feet and hands get cold, and then the face may flush up, and perspiration break out. Now it is true that palpitation with some or all of these accompanying symptoms attends some forms of heart disease. But it is equally true that it far more commonly is the result of digestive disorders, of poverty of blood (anæmia), and of similar conditions. It is necessary to urge this very strongly, for very many people are haunted with the fear of heart disease, because of such symptoms, when the fear is quite groundless. Nervous women are particularly liable to such forms of palpitation.

For palpitation as a symptom of goitre, see p. 288.

The **treatment** consists in attention to the diet, in the avoidance of everything that would tend to aggravate the condition, such as *excess in tea or tobacco*. Regular exercise, early hours, and avoidance of excitement should be practised. In many cases treatment for indigestion, and specially for flatulent indigestion (p. 231), is useful.

Fainting (*Syncope*, Greek, *sunkopto*, to knock to pieces, *Swooning*).—In fainting there is always enfeebled action of the heart. It may be the result of nervous excitement, shock, or strong emotion, severe pain, or loss of blood. The heart's action is suddenly and momentarily suspended or greatly diminished, the blood fails to circulate properly or in sufficient quantity through the brain, and unconsciousness is the result.

The **symptoms** are paleness and coldness of the skin, faint, shallow, and sighing breathing, feeble pulse, and it may be either quicker or slower than usual, giddiness, noises in the ears, indistinctness of sight, and loss of consciousness, the person falling to the ground limp and motionless. Sickness occasionally occurs; and the skin becomes covered with drops of sweat. Recovery from fainting is usually not long delayed, and is indicated by increasing strength of the pulse, return of colour to the face, and improvement in the breathing.

Treatment.—The person should be laid flat on the back, and all tight clothing round chest and neck loosened. Fresh air should be allowed, and cold water should be dashed over chest and face. These means are often sufficient to restore within a very short time. If the fainting fit persists, smelling salts or ammonia should be held to the nostrils. The heart may be stimulated to renewed activity by rubbing over the chest and by applying a sponge, dipped in hot water, directly over it. As soon as the patient has been sufficiently restored to swallow, two or three tea-spoonfuls of sal volatile in a little water, or a table-spoonful of whisky or brandy in water should be given. If these cannot be swallowed they may, if necessary, be thrown up into the bowel by means of a syringe. In very persistent cases the heart's action has been restored by galvanism.

Apart from such immediate treatment a person liable to fainting fits should be put on a course of tonic treatment, as the general state of health may indicate.

ANGINA PECTORIS.

Angina Pectoris means literally breast-pang. It is a very peculiar disease, and was first properly described by Dr. Heberden, who named it because of the sensation of strangling in the breast, which is its chief symptom (Latin, *ango*, to strangle, and *pectus*, the breast). Its cause is not properly known, but after death the hearts of those who suffered from it have been found the seat of degenerative changes, and, in particular, the coronary arteries, which come off from the commencement of the aorta, have been found hard and rigid by the deposit of lime salts in their walls—**calcareous degeneration**.

Symptoms.—The disease attacks in spasms, and between the spasms the person may be in apparently good health. The spasm commonly comes on when the person is walking or making some slight bodily exertion. It consists in a peculiar pain felt about the region of the heart, and extending to the left shoulder and down the left arm to the elbow. The pain may be aching or numbing, or give the impression of severe tightening. Under its influence the person instantly becomes still, and is possessed with the dread of impending death. His face is pale and haggard, the skin is covered with clammy sweat, and he has a sense of suffocation, although there is no difficulty in breathing. At first, as a rule, the attack passes off in a short time, and the person is himself again. But the spasm recurs after a longer or shorter interval. Gradually the intervals become shorter and the spasms last longer, and sooner or later the person dies in an attack. Sometimes, however, long intervals occur between two attacks.

Neuralgia of the heart is sometimes spoken of. Its symptoms are those of angina. It is the term applied when no disease of the heart is found to account for the spasms.

Treatment is directed to relieving the spasm when it occurs. All that can be done to ward off attacks is to avoid exertion or straining of any kind, excitement and fatigue, and excess in eating or drinking. To relieve the spasm stimulants are used, ammonia, brandy, or ether ($\frac{1}{2}$ to 1 tea-spoonful). Of recent years nitrite of amyl has been found specially useful—5 drops are placed on a handkerchief and inhaled. Persons liable to the attack should carry a small bottle with a tightly-fitting stopper, in which is placed a little cotton with 5 to 6 drops of the nitrite on it. As soon as the attack threatens, the vapour should be drawn up into the nostrils. The nitrite is also put up in little glass beads—5 drops in each globule. When required, one is crushed between the folds of a handkerchief and inhalation practised. Nitro-glycerine is also a very useful drug, in tabloids of $\frac{1}{100}$th grain.

CYANOSIS OR BLUE-DISEASE.

Blue-disease is a condition in which the blood is denied its due amount of air. As a consequence the blood never has the bright-red colour of proper arterial blood, but is purplish from the excess of carbonic acid gas (see p. 295); and thus the surface of the body exhibits a more or less livid hue. It is a common result of diseases of the lungs which interfere with the proper exchanges between the blood and the air. It will, therefore, be discussed under Diseases of the Respiratory System in the succeeding section. But it is also produced by diseases of the heart, and specially by a defective condition of the heart which dates from birth. In this condition a communication exists between the upper chamber of each side of the heart. The result is that venous blood entering the right auricle, which ought to pass down to the right ventricle, and then to the lungs, to be purified before gaining the left side of the heart, passes in part straight through to the left auricle, escaping the lungs. The blood distributed to the body from the left side of the heart consists in part of blood purified by the lungs and in part of blood not so purified. This disease, being one dating from birth, is considered at greater length under Diseases of Children (Sect. XXVII.).

DISEASES OF ARTERIES.

INFLAMMATION AND DEGENERATION OF ARTERIES: ANEURISM.

(Refer to Plate XVIII.)

Inflammation of the inner coat of arteries is characterized by patches of thickening due to increased cell development. The thickened patches encroach on the channel of the vessel, and may block it. The disease depends in some cases on syphilis or other bad conditions of the system, such as defective diet, intemperance, over-exposure to cold, &c., would produce. Sometimes it is a consequence of other diseases.

The **symptoms** are mainly due to the obstruction to the flow of blood. Thus the part which is supplied by blood from the vessel will be improperly nourished, and may pass into gangrene (mortification) if the vessel be blocked. Where the blocking and inflammation are due to a clot filling up the vessel, pain and tenderness are felt in the line of the vessel.

Degeneration is an accompaniment of inflammation. The cell growth of the inflamed patches breaks down into fatty material, and, if this be swept away by the current of blood, an ulcer is left on the inner coating of the vessel. If the degeneration has passed deeply into the substance of the wall of the vessel, that part will be seriously weakened, liable to stretch or burst, and thus aneurism may be produced. **Atheroma** is the term applied to this degenerative change in an artery. Another form of degeneration is the calcareous. Chalky material becomes deposited in thin plates in the inner coat of the vessel, and sometimes throughout the muscular coat of the wall of the vessel as well. The vessels lose their elasticity in consequence, and become quite hard. In vessels that lie near to the surface the rigid tubes are easily felt by the finger, and clearly indicate what is going on.

Aneurism (Greek, *aneuruno*, to widen or dilate) is a pouch-like swelling or bulging formed in connection with an artery. The **true aneurism** is formed of a part of the wall of the artery which has been unable to resist the pressure of the blood within the vessel and has slowly bulged out. This usually happens in an artery that is the seat of fatty or calcareous degeneration, by which its walls have been weakened. The walls of the sac of the aneurism are thus formed of the walls of the artery, but do not necessarily exhibit all the three coats possessed by a healthy artery (see p. 305). An aneurism may be formed in connection with a vessel by rupture of the vessel occurring, through a diseased part of the wall, for example. If the escaped blood is hemmed in by the tissues surrounding the artery, so as to form a sac, while, at the same time, the opening in the vessel remains as a means of communication, a **false aneurism** is formed. A wound from the outside may occasion aneurism in a similar way.

The causes of aneurism are thus disease of the arterial walls, diminishing their power to resist the pressure of blood from within, or injury of the vessel by violence from without. Strains, excessive and sudden muscular effort, &c., may lacerate the coats of an artery and so diminish its resistance as to lead to aneurism. Men are more liable to it than women, and it is chiefly a disease of advanced life, though it does occur in the prime of life.

The usual history of an aneurism is that, being caused by a yielding of the walls of the

Plate XVIII

ROENTGEN PHOTOGRAPHS OF THE CHEST

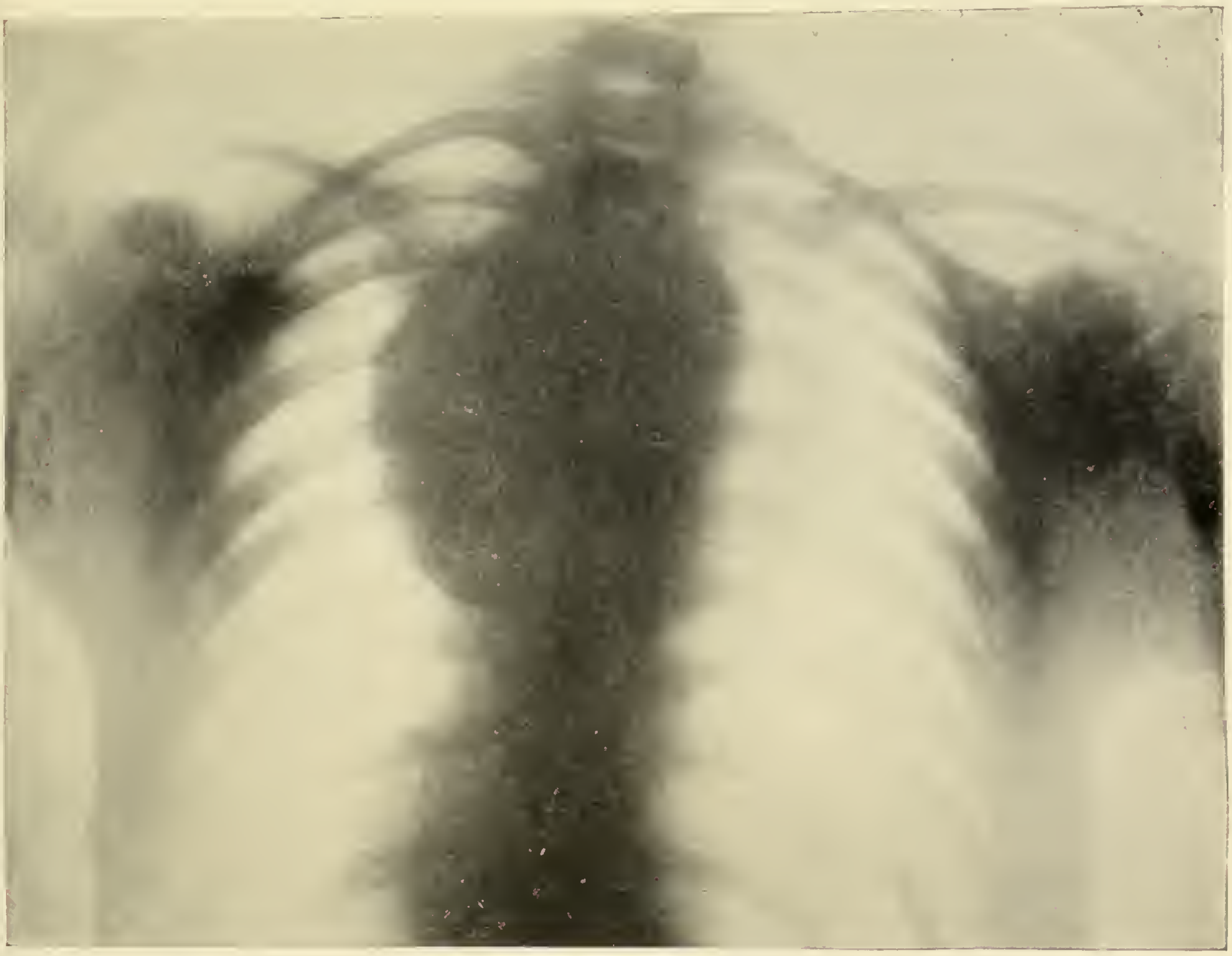
Taken from the Back

The upper photograph shows the shadow of a large dilatation of the main blood-vessel springing from the heart. This figure should be compared with the normal appearance, shown in Plate VIII.

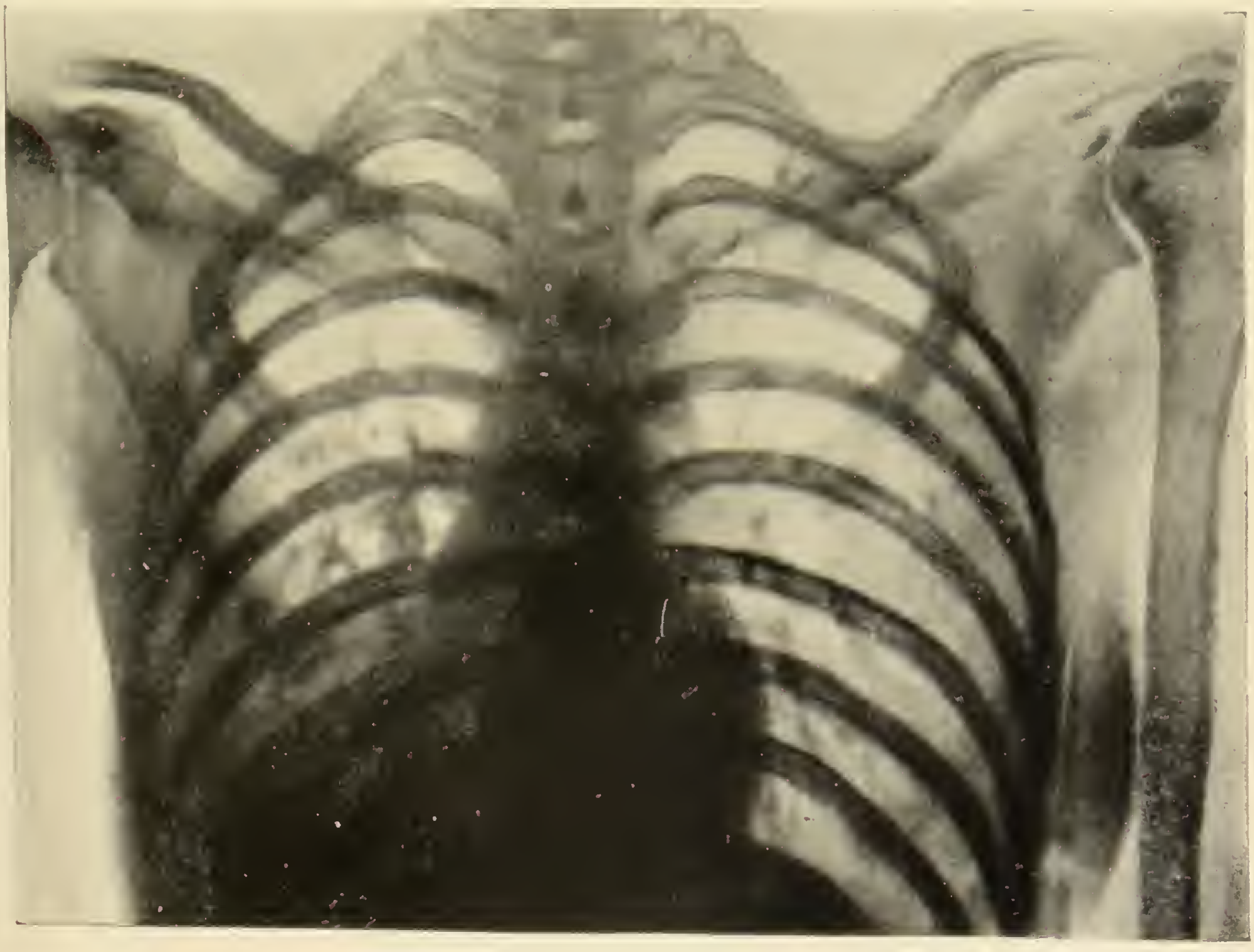
The photograph shows the view from behind. The shadow of the heart is obscured by that of the dilated vessel, but besides the position of the photographing tube, adjusted to give a full shadow of the aneurism, would not throw a good shadow of the heart.

The lower photograph also shows the view from behind, but the heart shadow is well seen. It is obscured, however, on the left side by the absence of clearness in the lung area. The clear area of the left lung is much contracted and deeply mottled. This is due to disease of the lung producing condensation of lung tissue, and deposits of solid material through which the rays pass less easily than through healthy lung.

ROENTGEN PHOTOGRAPHS OF THE CHEST



Aneurism of main blood-vessel (aorta)



Deposits of tubercle in the lungs, viewed from behind

artery before the pressure of the blood, and that pressure being constant, the yielding is apt to continue, the more because, as the sac enlarges, its walls must become thinner. As it expands it exerts pressure on the tissues and organs which are in the neighbourhood. Sometimes, owing to the pressure, neighbouring parts become matted to its walls, and do something to prevent its bursting. Within the sac also changes take place. The inner surface is rougher than the usual smooth inner lining of a blood-vessel, and the blood in the pouch may be more or less stagnant, depending on the size of opening from the artery into the pouch. Both of these conditions tend to produce coagulation of the blood. Fibrin is separated from the blood and deposited on the inner surface of the sac. This often goes on till layer after layer of fibrin is formed. In such a way it is possible for the sac to become filled up, in time, by a mass of fibrin clot, and for a cure to be effected naturally. Various causes, however, frequently co-operate to prevent such a desirable result, and as a rule the aneurism enlarges, unless means are successfully adopted to prevent it.

The **symptoms** of aneurism vary according to its position. If it is not within the chest or belly, but in the neck or limbs, it appears as a tumour. The hand placed over it detects a pulsation in time with the beat of the heart. Any tumour placed over an artery would communicate the pulsation of the artery to the hand; but a tumour apart from the artery might be pushed or lifted from the artery, when the pulsation would cease. This cannot be done with an aneurism. The swelling is from the commencement a soft one. Sometimes uniform and regular pressure will succeed in emptying the sac, and as soon as the hand is removed the blood fills it up again. If the artery be compressed between the tumour and the heart the swelling becomes relaxed. Severe pain is occasioned by pressure on nerves; veins may be obstructed, leading to dropsy; and the constant pressure will even cause eating away of a bone. Of aneurisms in the limbs the most frequent is that situated on the artery in the popliteal space, the space between the hamstring muscles behind the knee. Next comes the femoral artery in the groin. Aneurism of the carotid and subclavian arteries (see p. 306) are not uncommon. Commoner than all these, however, is aneurism of the aorta. Occurring as it does within a cavity of the body it is not so easy to recognize. Thus aneurisms occur in the chest connected with the aorta in the immediate neighbourhood of the heart, or connected with the arch of the aorta, or with one of the large vessels springing from it, or with some part of the aorta as it descends through the chest towards the belly. These are called **thoracic aneurisms.** Aneurisms also occur on the aorta in its course through the cavity of the belly, or connected with one of its large branches. These are **abdominal aneurisms.**

Now aneurisms in the chest or belly may attain such a size and bulge so much forwards that they are readily recognized as pulsating tumours. Thus a chest aneurism from the arch may bulge forwards, pressing on ribs and breast-bone, and may, by its pressure, eat through the ribs and breast-bone and appear as a regularly heaving mass, perhaps pushing its way up into the root of the neck, and threatening to burst through the skin. But, on the other hand, they may not project in this way, because of their situation, and there may be no visible external sign of their presence. In such cases the symptoms of their presence are due to the pressure they are exerting on surrounding parts. Thus constant aching and shooting pain is likely to be the result of involving nerves. One of the nerves of the windpipe may be involved and loss of voice result. Pressure on the windpipe affecting breathing and producing spasmodic cough, pressure on the gullet causing difficulty of swallowing, pressure on veins leading to congestion and dropsy of some part of the body according to the vein that is obstructed, and so on, are some of the symptoms that may be produced by the aneurism. Aneurism of the arch of the aorta may also affect arteries in its neighbourhood. Thus the artery going to one arm may be obstructed, and the pulse of that arm be absent or very feeble.

Thus whether the aneurism be external or internal it will require skill and experience to determine its true nature.

Treatment. — The treatment of external aneurism (aneurism not within a cavity of the body) is more simple than that of the internal variety. It naturally requires a surgeon, but various methods may be adopted. One method is to compress the artery nearer the heart than the aneurism, so as to delay the flow of blood and provoke the formation of a clot; another is to tie the artery. The flow of blood is finally stopped in it, but gradually its branches above the tied part enlarge and carry on the circulation. Till that is accomplished, great care is requisite to keep the limb warm by wrapping in cotton-wool, &c., lest mortification set in before the circulation is properly restored. It has been mentioned that sudden violent strain may produce aneurism, and the person often feels as if something had given way. If after such an experience a person finds a heaving tumour forming in the course of one of the arteries of the limbs, he ought to go to bed, and avoid interfering with the tumour, till surgical aid is obtained. In the event of an aneurism bursting, the main blood-vessel of the limb should be compressed as described under ACCIDENTS and EMERGENCIES.

The treatment of internal aneurism cannot be conducted on such lines. The patient is kept quiet in bed, and is allowed limited diet, in the hope that the formation of a firm clot in the sac will thus be aided. Some drugs, and especially iodide of potassium, are supposed to aid this result, and opium is used to relieve pain. Where the aneurism has projected from the chest wall, needles connected with galvanic batteries have been introduced into the sac, and the current passed for a few minutes at a time. This has been done for the purpose of aiding in coagulation of the blood in the sac, and has been successful in some cases.

THROMBOSIS AND EMBOLISM.

These are two conditions leading to blocking up of a blood-vessel by a clot. In **thrombosis** the clot forms *at the place* where the obstruction occurs, due, it may be, to the sluggish movement of the blood in the vessel, or to some diseased condition of the inner wall, leading to the formation on it of fibrin. The clot is called a **thrombus** (Greek, *thrombos*, a clot of blood). It is by the formation of a clot that a vessel that has been torn or injured becomes closed. Of course by this occurrence the continued movement of the blood in that vessel is prevented, and, if it be an artery, the nourishment of the part supplied by the vessel is defective. If it be a *large* artery mortification of the part (gangrene) is apt to arise. If the obstructed vessel be a vein, the return of blood from the part is impeded, and congestion, dropsy, &c., result.

In **embolism** the clot comes *from a distance*, and goes on in the current of the blood till it reaches a vessel too small to permit its onward progress, which it blocks. The clot is called, in this case, an **embolus** (Greek, *embolos*, a plug). Its effects are similar to those of thrombosis. It is needless in a work of this sort to discuss the symptoms of either of these conditions. It may be remarked that embolism, occurring because of small clots detached from the valves of the heart, diseased by attacks of rheumatic fever, for example, is common, and leads to plugging of vessels, specially in the brain, liver, kidneys, &c. Sudden paralysis and death frequently are due to plugging of some important vessel in the brain by a clot detached from diseased valves of the heart. The part played by emboli in pyæmia is noted on p. 315.

WOUNDS OF ARTERIES.

See under ACCIDENTS AND EMERGENCIES.

DISEASES OF VEINS AND CAPILLARIES.

Inflammation of Veins (*Phlebitis*, Greek, *phleps*, a vein).—Veins may be inflamed owing to injury, or in consequence of dilatation (*varicose veins*), or some unhealthy condition of blood, or because of the formation of a clot (*thrombus*, see above) within them. Even if a clot be not present to cause the inflammation, the result of the inflammation will be to produce one, so that the vessel becomes blocked. Inflammation of veins sometimes occurs after childbirth.

Its **symptoms**, if the affected part can be seen, are thickening and hardening, swelling, and perhaps redness in the course of the vessel, and pain. Abscesses are apt to be produced; there is considerable fever, with foul tongue, headache, &c. Congestion of veins below the seat of obstruction, swelling and dropsy of the part, are results. Then if parts of the clots be detached, and carried into the current of the circulation, they will pass to various organs, blocking other vessels, and thus produce abscesses in lungs, liver, joints, &c.

Treatment, which must be under qualified direction, consists in keeping the person perfectly quiet, to diminish the risk of clots being detached, and in the administration of such food and medicine as the general condition of the patient demands. The limb should be raised, enveloped in wool and flannel, and at the outset warm applications may be needful to relieve pain and throbbing.

Varicose Veins (Latin, *varix*, a dilated vein) are veins that have become over-stretched by the pressure of blood within them. In addition the vessels become tortuous; and the dilatation is greatest in the neighbourhood of a valve, where pouch-like stretchings are formed. The veins of the lower extremities are very liable to the dilatation, and the pouched and gorged veins are seen running a very winding course, specially towards the inner side of the knee. Often also the fine branches are seen, lower down, forming here and there a blue tracery in the skin of the inner side of the leg and foot. Piles (p. 268) are a form of varicose veins.

The **causes** are various, but are largely mechanical. A congested liver and costive state of the bowels, by impeding the return of blood, and thus increasing the pressure in the veins, produce them. They are common in pregnancy, because of the enlarged womb obstructing the veins in the abdomen. Persons engaged in occupations that keep them standing most of the day are liable to suffer from them, and specially stout people.

Treatment.—A loaded state of the liver and bowels should be corrected by purgatives. Support to the vessels should be given where possible, by, for example, a well-adjusted bandage on the limb, or the use of a properly fitting elastic stocking. The pain and swelling of a limb produced by varicose veins are greatly relieved by rest with the limb supported in an elevated position.

Death from bleeding has occurred by bursting of greatly swollen veins. If a vein burst in the lower limb, the leg should be raised and pressure applied over the vessel as directed under ACCIDENTS AND EMERGENCIES.

Thrombosis and Embolism may occur in veins as in arteries, in fact in all kinds of vessels. (See preceding page.)

Blood-vessel Tumours (*Angeioma*, *Nævus*, *Mothers' Mark*).—These are growths of irregular shape formed of enlarged and dilated vessels. They may be formed mainly of arterial vessels, in which case the tumour is of a bright colour, and beats in time with the heart. If veins form the growth, it is of a dark hue, does not beat, feels doughy, and is easily emptied by pressure. While, again, there may be no tumour, properly so called, but simply a red patch in the skin. This is composed of dilated capillaries, and is the form to which the term *Mothers' Mark* is applied. Such marks are present at birth. In some cases they waste during early childhood, in others they spread. They occur specially in the skin and about the head.

Treatment.—If they are small, and not increasing or troublesome, they should be left alone; if otherwise, methods are adopted to stop the flow of blood through them by exciting inflammation and causing destruction of the vessels, or by tying the vessels in some way. A great many means are tried to accomplish such ends; but a surgeon will adopt the method suited to the particular case.

INFLAMMATION.

Inflammation is the term used to describe a series of processes which occur in a tissue which has been exposed to injury or irritation. In the production of the changes that follow the injury or irritation, the blood-vessels of the tissue play a chief part; and the signs of inflammation apparent to the senses, namely, redness, heat, and swelling, are the direct result of the occurrences in the vessels.

The tissue itself, outside of the vessels, also takes its share in the inflammatory process.

CHANGES THAT OCCUR IN INFLAMMATION.

Changes in the Blood-vessels in inflammation.

To understand the nature of these changes it is necessary to recall the characters of the blood and of its movement in the blood-vessels, as seen under the microscope.

We remember that the blood contains red and white cells or corpuscles (p. 292), the white being few in comparison with the red; and that, when the circulation of blood is seen, say in the web of a frog's foot, the blood is observed to flow in an even stream in the capillary blood-vessels, easily and uniformly, the current of blood corpuscles—red and white mingled—passing along the centre of the vessel, and not adhering to its walls.

Now if the part being watched under the microscope be irritated or injured in any way, at once a remarkable change takes place in the vessels. They widen, and an increased quantity of blood flows to them. Blood-vessels but faintly perceived before the injury are now very plain because of their increased size, and others formerly invisible from their narrowness now start into view. There is manifestly a much larger quantity of blood in the part, and this increase in quantity is accompanied by its signs of increased redness and warmth. At first also the current of blood is not only fuller but faster, and the part may throb with the fulness and speed of the stream. But soon the blood begins to flow less quickly through the vessels; the current is delayed. To this stage in the process of inflammation the term **congestion** is applied. This is not yet inflammation. If the irritation has been slight, or has been quickly removed, the excessive quantity of blood may pass away, the vessels gradually recover their former size, and no signs of any unusual occurrence remain.

But if the irritation be great, or continue, the process goes on. As a result of the fulness of the blood-vessels, and the pressure exerted by the blood within them on their walls, leakage takes place, and fluid passes out of the vessels into the surrounding tissues. On this account, as well as because of the large quantity of blood in the part, some degree of swelling is apparent. It is this **exudation**, as it is called, that goes to form the fluid found in quantity in such serous cavities as that of the pericardium, surrounding the heart, or that of the pleuræ, surrounding the lungs, when these membranes are inflamed, as in dropsy of the heart (p. 318), and pleurisy (p. 359).

Accompanying such changes is another of remarkable importance. The observer, watching carefully through his microscope the effects of irritating the frog's web, perceives that, with the slowing of the current, the white blood corpuscles quit the centre of the stream and begin to loiter along the walls of the vessels. So that instead of a central stream of corpuscles in the vessels, with clear margins, there is a central stream of red corpuscles, but a row of white corpuscles on each side, which soon cease to roll along, and adhere to the walls. They do more than this. The white cells send out processes which pierce the fine walls of the vessel, and gradually these processes grow till the cells themselves are found bodily transferred to the outside of the vessel. The curious thing is that no opening can be discerned through which the cells could pass, but, all along the capillaries of the inflamed district, white cells are seen either lying outside of the vessels or in various stages of their passage through the walls. A school-boy will blow a soap-bubble, and will pass peas and coins through its walls without rupturing them or destroying the bubble; and we can only suppose that, in a similar way, the white cells pass through thin blood-vessel walls without any breach of substance. In severe attacks, red cells also escape from the over-full vessels into the surrounding tissue. Fig. 146 illustrates the appearances of a piece of tissue in which these occurrences are taking place.

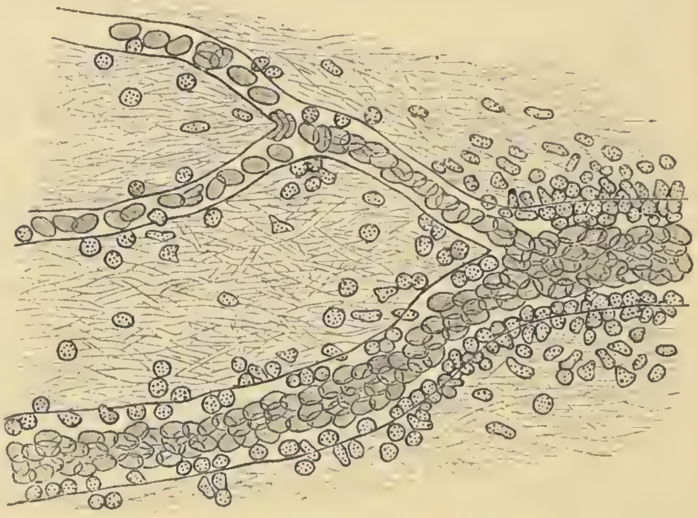


Fig. 146.—The appearance under the microscope of a minute piece of fine tissue which has been irritated. A blood-vessel is shown branching. The red corpuscles are seen streaming down the centre of the vessel, the white corpuscles are rolling along the walls of the vessel, adhering to them, and passing out of the vessel in great numbers, and finding their way in the direction of the seat of injury.

The final stage of the inflammatory process, as regards the blood-vessels, is that the blood experiences ever-increasing difficulty in passing onwards, until at length the flow ceases altogether in the inflamed part, the vessels remaining choked with blood. This is the stage called **stasis**, that is, stoppage.

Changes in the Tissues, outside the blood-vessels, also occur in inflammation.

These tissues are found crowded with white cells, a large number of which consists of those that have emigrated, as the phrase is, from the vessels, many of them being doubtless descendants of the emigrant cells, which have the power of multiplication by division, and some being, perhaps, produced by the tissues, which share in the inflammation. The cells that have escaped from the vessels are remarkably active, exhibit the amœboid movement described on p. 293, by means of which they push their way through the tissues and wander some distance from the vessels out of which they have come. On this account they have been called "**wander-cells.**"

Three things must be borne in mind regarding the tissues themselves: firstly, the injury or irritation has damaged them, diminished their vitality, perhaps actually quite destroyed the vitality of some portion; secondly, they are invaded by the numerous white cells escaping from the vessels, as described, and they are being saturated and compressed by the fluid exuding from the vessels. In these two respects the tissues may be regarded as mere passive victims of processes in which they play no part. It must not be forgotten, also, that the injury or irritation may be continuing. But, thirdly, unless the injury or irritation has been so intense as either immediately, or quickly, to destroy or kill the tissue altogether, the tissues themselves "react" to the inflammatory process. One of the chief evidences of this is that the cells of the tissue itself become active and proceed to multiply, so that speedily large numbers of round cells are produced within the area where the inflammatory process is going on. It has been pointed out that every special tissue whatever—muscle tissue, nerve tissue, and so on—contains a supporting and packing connective tissue (see p. 56), and that this connective tissue, besides containing round cells, is always and everywhere more or less rich in special connective-tissue corpuscles. It is particularly these cells which become active and proliferate or multiply. Thus the area which is the scene of the inflammatory process becomes crowded with white cells, a large number of which have emigrated from the blood-vessels, or are the offspring of emigrant cells, but a large proportion of which also have been produced, from the fixed cells of the tissues, by the reaction of the tissues themselves.

What explanation can be offered of these two sets of changes? There is no doubt that the explanation is twofold.

In part the changes are due to the fact that the area is damaged or irritated. The widening of the blood-vessels and the fuller supply of blood is to some extent caused by a species of temporary paralysis of the vessels' walls by the injury or irritation. They lose their tone, lose their grip, so to speak, of the blood stream, and the blood, therefore, from neighbouring uninjured vessels surges into them. Some alteration of the walls also occurs, so that the cells roll along them less easily, and tend to stick to them, and it is doubtless owing to this change—this lowered vitality—of the vessel walls that the cells are able to work their way through them, and that they permit the oozing through them of a much larger quantity of fluid than they would do if their vitality had been unimpaired. That some of the changes occurring outside the vessels, in the tissues, are also merely the result of damage is evident from the fact that many of the cells that escape from the vessels into the tissues there liquefy and break down, as do also many of the cells of the tissues themselves. But this is not the whole explanation. For if a fine, very slight wound be made, with a perfectly clean sharp instrument, in a tissue so thin as to be capable of observation under a microscope, similar changes are observed in the widening of blood-vessels, increased flow of blood, emigration of white cells, and rapid production of new cells by the injured tissue, where there is no evidence of liquefaction or breaking down, and where the only result is rapid repair of the breach that has been made, the changes in the vessels and in the tissues ceasing as soon as the repair is completed.

In part, therefore, the changes that have been described are due to an effort to repair the injury and to arrest the irritation.

We may, therefore, say that the changes that have been described, taking them altogether, are the evidences and consequences of two sets of processes going on side by side, one set being the effects of the injury and irritation to which the part has been subjected, and another set being the efforts of the part to repair the damage, and these two processes are going on simultaneously side by side—a destructive process and a reparative process. They are so mixed up together that it is impossible sharply to distinguish what change belongs exclusively to one process and what to the other. But, whether the result is the more or less complete destruction of the part, or the more or less perfect restoration of the part, will depend on which of the processes gains the mastery. To some extent the same change may be destructive or reparative according to the extent to which it goes. Thus the widening of the vessels and the increased flow of blood may be at once the result of the damage and the means of repair. If it does not go to excess, the increased blood supply, primarily due to the injury, may yet bring the material for repair, and the cells which escape from the vessels may, and indeed do, act as repairers of the breach that has been made. But if the vessels became so engorged that the circulation becomes completely arrested for a lengthened period, and the cells escaping are so numerous that the tissue becomes, so to speak, smothered with them, then the very excess of reparative material may only secure the death of the already imperilled tissue.

THE CAUSES AND RESULTS OF INFLAMMATION.

The Causes of Inflammation are numerous, but they may be placed in several classes. For instance, we may speak of **physical causes**, including in this class injury done by an instrument, which cuts or tears or bruises; or injury done, for instance, by a bullet, which enters the tissue and lies there; or injury done by electricity, by light or heat.

Then there are **chemical causes**. The injury or irritation done by acids, or caustic substances, would be included in this class.

But by far the commonest causes of inflammation are **living organisms, microbes**, organisms of the type classed generally as bacterial, which, gaining entrance to the tissues in one way or another, set agoing the various processes of inflammation by acting as irritants to the tissues, either by their own activity or because of the poisonous substances they produce in the course of their multiplication.

A study of the inflammatory process set agoing in a tissue by this last kind of cause reveals occurrences of a most remarkable and highly interesting character. In the case of injury by the other kinds of causes, the cut, the tear, the bruise, the burn, &c., the damage to the tissue has been done, and is finished, provided the instrument of injury, the knife, &c., has been perfectly clean. But in the case of inflammation set up by the introduction of a microbic poison, the injury or irritation is going on, the living poison is multiplying in the tissue, extending its ravages farther and farther. In the case of injury done by physical or chemical agents, generally speaking the reaction of the tissue would be confined to the breaking down and removal of the parts of the tissue destroyed by the injury, and the repair of the breach so made. But when the inflammation is septic, where, that is, it is due to the operation of microbic substances, the whole purpose, so to speak, of the inflammatory process, to begin with, is to kill or neutralize and expel the invading organism, and not till this has been accomplished can the process of clearing away destroyed elements of tissue be gone on with, or repair begun.

This primary necessity, the destruction or expulsion of the invading organisms, is the reason for many of the changes that go on in inflammation. The main agents in defending the tissue are the white cells, which pass out of the blood-vessels of the inflamed region and flock in enormous numbers to the irritated portion of tissue. It has been shown that the process by which they protect the tissue is two-fold; some of the white cells directly attack the organisms by incorporating them within their own substance. On p. 53 it has been described how the amœba surrounds by processes of its substance particles it comes into contact with, and thus incloses them within it, digesting them, or otherwise acting on them. So do the white cells swarm to the attack of the organisms of disease, eating them up, so to speak, and so depriving them of their power to injure the tissue.

Thus, within a short period of the introduction into the tissue of some infective material, large numbers of white cells, which have emigrated from the nearest blood-vessels, will have appeared upon the scene, and will be found crowded with the minute organisms of the infective material, which they have ingested. Cells which play this active part are called **phagocytes** (Greek, *phagein*, to eat up, and *kutos*, a cell).

But there is another method of defence against attack which the organism possesses. There are several varieties of white cells in the blood, as has been explained on p. 19, and illustrated on Plate III., p. 18. The cell *a*4 of that plate is specially the phagocytic cell, and the cell of the *a* group marked 3 has also phagocytic power. But other cells play other and not less heroic parts. The numbers of virulent organisms that may be introduced into the body by the prick of a dirty needle, or by a poisoned wound of any kind, may be so great as to make it impossible for the phagocyte cells to get at them all. The evidence is complete that the body is yet not without defence. Other kinds of white cells help the defence by breaking down, and so liberating from their interior substances which are unfavourable to the life and growth of the invading organisms, and it may be that some cells, without breaking down, are able to deprive the invading organisms of their power of mischief by discharging among them some of the granular material they manufacture. The cell numbered 5 of the *a* group in Plate III. seems to have this power.

In the description of what occurs in inflammation, reference was made to the fluid that exudes from the vessels and plays so large a part in the swelling of the inflamed region. This exuded fluid, it is highly probable, is not without its uses. It probably contains substances in solution unfavourable to the invading organisms, and, by bathing the injured or irritated tissue, the fluid may hinder to some extent continuance of the irritation, as well as dilute the poisonous material which has reached the tissue.

An inflamed region of the body, specially if the cause of inflammation is a dirty or poisoned wound, may then be said to be the battleground between invading septic organisms and defending white blood-cells, and the white cells defend in two ways:

(1) by rendering the region of attack unfit for the invaders to live in, by discharging into the fluid that bathes it material they produce, or
(2) by boldly issuing forth from the blood-vessels in myriads and eating up the invaders.

It appears that one set of white cells in particular has the duty of preparing and discharging, when required, this protective material, and another set has the duty of eating up the invader.

In performing these duties both sets of cells may be sacrificed in large numbers. The poison may be so virulent as to destroy the cells, at least those that first reach the area of attack. But many of the cells thus early on the scene will be those whose destruction and breaking down liberates material unfavourable to the life of the invader, and so even by their death will they protect the tissue by diminishing the activity of the assailant. Ultimately the energy of the invaders will thus be so reduced that they are a ready prey to the phagocytic cells that now fall upon them and quickly swallow them up.

It undoubtedly happens that many of the phagocytic cells, too, are unable to destroy the organisms they consume. It does not, therefore, always follow that organisms that have been picked up by cells are deprived of their power of mischief. The cell may be unable to kill and digest them. Instead, they may kill the cell which has swallowed them, and, again liberated, become agents of mischief.

In various parts of the battleground, therefore, varying fortunes will prevail, the defending cells triumphing here, the attackers there, and what the ultimate issue is will frequently depend upon the ability of the body to send continually fresh supplies of active white cells to the scene of conflict, or will be conclusively settled by the invading organism being so virulent as to paralyse all defence at the seat of attack, and being able to push its hosts inwards till the whole constitution is attacked and impaired.

The Results of Inflammation, it will be easy, from what has been said, to perceive, will vary—

Firstly, according to the nature, intensity, and duration of action of the irritation,
Secondly, according to the vigour and persistence of the reaction with which the body in general resists the irritant.

Thus, in some persons of weak physique and flabby constitution, the same irritant may induce a prolonged and extensive process, slow to cease, which in a person of vigorous constitution induces only a slight and temporary disturbance. Upon the same circumstances also will it depend whether the inflammation remains a merely local disturbance, however severe, or ends in a general and constitutional disorder.

Where the irritation is slight, the changes that have been described are little marked, the dilatation of vessels soon passes off, the cells that have escaped from the vessels and the exuded fluid disappear from the affected tissue, passing, with any that may have been destroyed, into the lymphatics, the drainage channels that exist in every tissue, and nothing is left to mark the occurrence.

This is called **resolution**.

This restoration of the tissue to the normal occurs after more intense degrees of irritation, but the irritation and the inflammatory process it provokes cannot pass a certain degree without some destruction of the elements of the tissue that has been attacked. These destroyed elements break down and are removed, but the healthy cells of the tissue proceed to replace the destroyed material by a growth of new cells, which gradually become transformed into fine fibres. These fill up any gaps, so to speak, that have been caused in the tissue. They gradually shrink, forming a firm fibrous band, or bundle, or mass, marking the spot where the damage has been done. This is called a **scar** or **cicatrix**. It replaces the tissue that has been destroyed, but it never becomes converted into the same structure that it replaces. On the surface of the body the place where a sore has been, or wound, or burn, is always marked by the spot, or line, or irregular mark, different in colour from the rest of the skin, less elastic. In internal organs the same thing occurs. In examination of the body after death it is always possible to tell where inflammation leading to permanent damage of any extent has occurred in any of the organs—heart, lungs, liver, kidney, stomach—by the presence of such bands, or masses, or patches of scar tissue.

In some cases, owing to the character of the inflammatory process, there may have been no such destruction of tissue as to necessitate filling up of gaps, but yet, as the result of the irritation, new growth has gone on within the irritated area. In such cases, when the inflammatory process has ceased, the area remains thickened, and more dense than normal. Such thickenings may persist; but also they may in course of time gradually lessen by degeneration and absorption of much of the new material. In such cases the new growth does not occur in bands, or patches, or masses, but is rather infiltrated, as the phrase is, diffused within the whole area where the inflammation existed.

But again, the irritation may be so intense that the white cells that flock from the dilated blood-vessels to the seat of irritation fall victims to the attack and become transformed into matter, **pus**, as it is called, while also the elements of the attacked tissue are destroyed by the irritation. This is called **suppuration**. If this occurs on the surface of the body, then a breach is made in the surface, and what is called an **ulcer** is the result, the yellow or dirty discharge from which consists of the destroyed elements of the tissue and of the multitudes also of white cells that have poured from the dilated vessels, mixed with the fluid that has exuded from the vessels.

This ulcer must be distinguished from what is formed, if by an injury a piece of the surface has been removed so as to expose the moist tissue beneath. On this raw surface a **scab** forms. This scab is formed by material oozing from the injured vessels—if it is seen unmixed with blood it is of a transparent straw colour—and of white cells from the vessels, which between them form on the raw surface a clot or coagulum, which later dries and forms a scab. Of course as this fluid wells up on the raw surface it will mix with any dirt or discoloured material it comes into contact with, but it is itself clear and pure to begin with. Under the protection it offers to the raw surface, healing goes on rapidly, so that when the scab drops off the wound is whole—if it has not meantime become infected.

But to return. If the irritation has been so intense as to destroy the elements of the tissue attacked, as well as the white cells that have hurried to the rescue, pus or matter is formed. Now, if this occurs, not on the surface, but in the depth of a tissue, then in the place which marks the centre of the irritated region the elements of the attacked tissue have been destroyed and transformed, with the white cells and exuded fluid from the blood-vessels, into a semifluid yellowish mass—dead material. This material occupies, as it were, a cavity in the inflamed tissue. But if one could study what is going on in the tissue, one would find it is not by any means inactive. In the heart of the fray death and destruction have been wrought, but the field is not therefore lost. All round the outskirts of this dead fluid-mass the same processes are going on that have been described already. There is, all round, a zone in which blood-vessels are dilated, white cells are pouring from them and multiplying, and the tissue cells of this zone are also proliferating. If it is in a situation where one's finger can feel it, this zone is marked to the touch as one of increased density and thickness. Indeed, by the inflammatory processes described, a wall is being hastily thrown up all round the central mass of dead stuff, a wall which, to begin with, shuts it off from the as yet unattacked region beyond and limits its power to hurt, and, to end with, will gradually broaden and thicken and so encroach on the dead centre till it crowds it into the smallest possible space.

Now the process by which the matter or pus has been formed is called **suppuration**, as has been already said, but the collection of matter so formed is called **an abscess**. If the abscess has formed somewhere on the external part of the body, it will probably show as an elevation of the surface, and if a finger of each hand be placed on the elevation, one on each side, and if the swelling be pressed first by one finger and then by the other, the matter will be displaced, as it would be if one were to press in the same way on any bag of fluid. The finger perceives this movement of fluid, which is called **fluctuation**, and so one distinguishes between a solid swelling and a swelling due to fluid.

Now it will be clear that if this fluid be permitted to escape, by means of a clean incision, then the process of regeneration going on all round in the active zone will get free play to invade the cavity, which will become speedily filled up by the new rapidly-growing tissue, and the destruction will be repaired. If one could look into such an abscess cavity, from which the matter had been removed, the new tissue would be seen as little firm red elevations all round the healing margin. These elevations consist of round cells and loops of fine blood-vessels, and they grow with marvellous rapidity, filling up even large cavities in a very short time. It is called **granulation tissue**, because of the granular appearance the growing margin presents. But this tissue is ultimately converted into the fine fibrous scar tissue already described.

In unhealthy persons or depressed constitutions the zone of healthy growing new tissue round the abscess may be poor and weakly. Thus the suppurating process may not be circumscribed, but may spread and work its way through extensive areas of the attacked region.

The worse degree of irritation is that in which the irritant is so powerful or so extensive that masses of tissue are killed at once, before reaction has time to occur. Pieces of tissue which die and separate in mass are called **sloughs**, and when a piece of tissue dies in its whole thickness it is said to become **gangrenous**. But round the circumference of the slough or piece of gangrene the same changes occur that have been so fully described as characteristic of inflammation, the purpose of which is first to protect the still living tissue, and second to separate the dead from the living and ultimately cast it off.

THE KINDS OF INFLAMMATION.

Wherever it occurs the process of inflammation is essentially one and the same; whatever differences occur are due rather to the situation of the process, or its duration, or to such causes as have been already discussed, depending upon the intensity and character of the injury or irritation. But it is necessary briefly to explain a few terms not yet referred to.

Serous Inflammation is inflammation of a serous membrane. This is the membrane which lines the closed cavities of the body, of which the best example is a joint, the serous membrane being there called synovial (see p. 64). The pleural sac surrounding the lungs is lined by a serous membrane (see p. 344), and so also is the similar double sac round the heart (see p. 298). The feature of inflammation in such membranes is the exudation of large quantities of fluid—serous fluid,—which separates the two layers of the membrane, and to this is due the dropsy that occurs in inflamed joints, the effusion that occurs in pleurisy, and the dropsy that may take place round the heart. But this is just an exaggeration of the oozing referred to as one of the occurrences from the blood-vessels of inflamed areas.

In such situations also the surface of the inflamed serous membrane may be covered with coagulable material, and if the effusion be not great, or be absorbed, then the opposed surfaces tend to become glued together or adherent to one another. As a rule suppuration does not occur in such cavities unless they have been infected by septic organisms from without.

Catarrhal Inflammation occurs on surfaces which are not shut off from the outside, surfaces lined by mucous membrane—the nose, throat, bronchial tubes, stomach, bowel, bladder, womb, &c. Such surfaces are lined by cells which secrete a material, called mucus, which maintains the moisture of the surface and is viscid enough to protect it also. When such surfaces are inflamed, the increased flow of blood causes great increase in the mucous secretion, and thus there is an actual flow from the surface, typically seen in catarrh of the nose and in bronchitis, which is a catarrrhal inflammation of the membrane lining the bronchial tubes. Such inflamed surfaces, being open to the air, are, of course, open to the deposit on them of organisms, so that such a catarrh readily becomes transformed from a mucous into a purulent one.

These two terms just described refer, we have said, to inflammation characterized by features due to the situation of the inflammation. Other terms applied to inflammation may rather serve to indicate their cause.

Rheumatic Inflammation, for instance, merely indicates that the real cause of the inflammatory process is the rheumatic poison.

Gouty Inflammation similarly indicates that it is the gouty tendency, the uric acid poison, that is at the root of the inflammatory process. But so little do these terms necessarily indicate any essential difference that a serous inflammation may be rheumatic or gouty in origin, and so also may a catarrhal inflammation.

For a fuller discussion of the nature of rheumatic or gouty inflammations the reader should refer to pp. 552, 554.

To simplify the discussion of inflammation, we have gone on the assumption that its causes are always introduced from without by a wound or the introduction of a poison, and so on. We may now add that the cause of inflammation may arise from within the body. The poisons of rheumatism and gout, just referred to, are cases in point. They are produced within the body, and by the blood are carried to all parts of the body. Microbic poisons may, similarly, be carried by the blood stream to every part of the body and may thus provoke inflammatory changes of one kind or another at situations very distant from one another.

In a word, the gouty or rheumatic person produces in his own body the material that, distributed by the blood stream all through his body, sooner or later injures or irritates one tissue or organ or another. This is the explanation of the fact that such a person may one day have a rheumatic or gouty inflammatory attack of a joint, another day of an eye, another time of the throat, and so on. In every case, whether it can be identified or not, the reason for one organ or tissue being the seat of attack at one time, and another organ or tissue at another, will be that that particular organ or tissue has been subjected to some unusual or undue strain, has had its vitality temporarily depressed, and so its resistance to the gouty or rheumatic poison, ever more or less flowing through it, has yielded to the strain.

In all such cases, however, the inflammatory process is essentially that which has just been fully described.

SYMPTOMS OF INFLAMMATION.

There are four chief symptoms of inflammation, namely, **redness, heat, swelling,** and **pain.** These can each be related to the occurrences in the inflamed region which have been already fully described.

Redness and heat are both due to the increased quantity of blood flowing to the part along the widely-dilated blood channels. The redness may vary from a bright pink in the early stages, when the blood is easily passing along the vessels, to a duskier hue as stagnation tends more to occur. If complete congestion is taking place, then the part assumes a deep-purplish hue. The recognition of the causes of these differences in colour is of the utmost importance from the point of view of treatment. For instance, heat or cold may be applied locally to an inflamed region, in some cases iced cloths may be a suitable application, and it is sometimes difficult to say beforehand whether heat or cold will be the more suitable. But if the part is rosy red, one knows that while there is an active rush of blood the vessels are not blocked, and the stream is flowing on freely. In these circumstances cold is more likely to be useful by contracting the still active vessels and limiting the rush. But if the part is already purple, the vessels choked with blood, and that blood nearly stagnant, one knows the whole area must be of greatly impaired vitality, and cold can only still further impair it, and possibly irretrievably damage it, while warmth may be able to promote a restoration of the flow.

While the heat of the inflamed part is greater than that of surrounding parts, it is not higher than that of the blood in the interior of the body.

Swelling is due to the cells which have migrated from the blood-vessels and to the fluid exuded from them, as well as to the excessive quantity of blood in the part. In later stages of inflammation it will also be partly due to the production of new cells by the inflamed tissue. It will depend upon the proportion of each of these contributing causes whether the swollen area is to the touch firm and hard, or boggy and dropsical — **oedematous,** as the technical word is. In the latter case the swelling is due mainly to fluid effusion.

Pain is due to pressure upon nerve-endings within the inflamed tissue, exerted by the accumulated cells and exudation. Wherever, therefore, the tissues are dense and yield with difficulty, the pain is more severe; wherever the tissues are lax, and room can easily be made for the increased material among the tissues, the pain is less. This explains why toothache is so severe, the products of inflammation, being confined within the narrow space of the pulp cavity of the tooth, pressing on the sensitive pulp. It also explains why the pain of inflamed bone is of so boring and intense a character.

Referred Pain.—Pain is not always confined to the region of inflammation, is indeed not always felt there. In early stages of hip-joint inflammation the pain is felt at the knee; the pain due to appendicitis may be felt at first, not over the site of the appendix, but in the region of the navel, and at the pit of the stomach. Pain thus felt at a distance from the seat of production is called **referred pain.**

Loss of Function, more or less, occurs in an inflamed part, due frequently to the paralysing effect of the pain, but partly also to the mechanical difficulty caused by the swelling.

Attending these local symptoms there may occur other symptoms indicating that the body in general is being affected by the local inflammation. The most common of these is a rise in the temperature of the body, that is to say, **fever.** This is discussed elsewhere (see p. 504).

THE TREATMENT OF INFLAMMATION.

Inflammations of External Parts.—It is not difficult to lay down the broad principles on which treatment of inflammation, wherever occurring, should proceed. But it is not always easy to apply these principles in detail in any given case. For instance, one may truly say that the treatment of an inflamed little finger and of an inflamed kidney is in principle the same, but the detail of the treatment, as applied to the little finger, can be easily understood, and as easily put into operation, but the most intelligent person, who had no medical training, would find it difficult to deduce from the treatment of an inflamed little finger what he should do in a case of inflammation of the kidneys.

For the sake, therefore, of clearness, we shall, for the moment, put aside internal inflammation, and consider the proper lines of treatment to follow where the inflamed region is some easily-reached part on the surface of the body, a limb for preference, say inflammation of the hand.

Clearly the first thing to ask in such a case is—

What is the cause of the inflammation?

and following the answer to that question there are others, namely—

Is the cause still present?
Is it still in operation?
Is it removable?

For instance, the cause of the inflammation may have been a wound, a bruise, a tear, a scratch, a burn, corrosion by a strong acid or alkali. If the wound has been caused by a knife—let us say, for the moment, a clean knife,—obviously the cause is over and done with, and the treatment is simple. But if the wound has been caused by a bullet, then the question arises, is it still in the wound? or if the wound has been caused by broken glass, is a fragment of the glass possibly embedded in the wound? If a needle, pin, or such foreign body has caused the injury, may a fragment not have broken off and be still present? The same question would require to be settled if a burn had been due to red-hot metal. In the case of acid or alkali, the material may not have been completely removed from the surface and may still be acting.

The Removal of the Cause is in all cases, therefore, the first thing to assure one's self of.

Now this seems easy enough in the cases that have been mentioned. But it has already been noted that the commonest causes of inflammations are septic substances, microbic poisons. It is not easy to say when they are present and when they are not. That is why emphasis, in the case of an injury by a knife, has been laid on the cleanness of the instrument, and the same applies to needle, pin, and all instruments that break the surface. For in such a case the inflammation may not be the mere reaction of the tissue to the injury, whose purpose is limited to the repair of the breach, but irritation also due to substances introduced into the wound. The prick of a pin may set up a most violent and dangerous inflammation, not because of the tiny wound, but because the pin was not clean; and the septic material upon the pin point may be so minute as to be invisible, while its virulence may be unbounded.

To answer the question, then, whether the cause of the inflammation is still present, is not so easy as it sometimes looks. For, in the case of a wound by a knife, it may be quite easy to say that neither the knife nor a fragment of it remains in the wound, but the question is not yet answered whether the knife has not introduced septic material which is the real cause of the inflammation persisting.

The removal of the cause, therefore, is not limited to the assurance that no tangible foreign body is present to cause a continuance of the inflammation, but ought, if possible, to guarantee that septic material is not present. Now we have already said it is impossible usually to tell whether septic material has gained entrance to a wound or not. The only safe procedure, therefore, is to assume the extreme likelihood of this having occurred, and to act accordingly.

The direction, therefore, to discover and remove the cause of inflammation includes such steps as shall, if possible, guarantee the cleanness of any wound or bruise that may attend the inflammation or be in its neighbourhood.

The first direction, therefore, in the treatment of inflammation becomes something like the following:—

> **Wherever inflammation is associated with a wound, make sure that no tangible foreign body is present, then thoroughly cleanse the wound and all the neighbouring surface with an antiseptic lotion of some kind.**

The details of such lotions are given under TREATMENT OF WOUNDS, p. 530, Vol. II.).

Keep the inflamed part at rest is the next most vital injunction. In the case, for instance, of the inflamed hand, the continued use of the hand can only help to maintain and aggravate the inflammation with its attendant throbbing of pain. Keeping the part at rest may, in many cases, imply the application of a bandage, or a splint and bandage, or a plaster bandage. Nothing so effectually relieves an inflamed joint in many cases as rest secured in such a way.

Elevate the inflamed part is the next direction. For instance, it would be profitless to put a bandage on an inflamed hand and go about with the arm hanging ; the hand should be kept raised in a sling. If the inflamed part be below the level of the heart, gravitation will tend to make the rush of blood to the part even greater than it would be otherwise. Raising the part, on the other hand, brings gravity to the aid of the inflamed area, doing something to help in the emptying of the engorged vessels, and the diminution of the swelling. Wherever inflammation attacks a dependent part, the foot, for instance, swelling is likely to become very great, unless the foot is kept raised.

These directions, one may say, are of universal application, and are worth summarizing, thus:

(1) remove the cause of the inflammation,
(2) cleanse and keep the part clean,
(3) keep the part absolutely at rest,
(4) raise the part somewhat above the level of the heart.

If these directions are followed at the outset it will frequently happen that little else is needed.

External applications are, however, frequently valuable aids in the relief of inflammation. Now it is not difficult to explain in general terms what purpose these external applications should serve.

Cold may be employed to diminish the flow of blood to the irritated area, and contract the blood-vessels. Cold applications are also, when rightly applied, very soothing to the irritated nerves, by their action on the vessels causing a lessening of the swelling, as well as by a directly soothing effect. Cold may be employed in the form of a local bath, cold cloth, cold drip or cold coil, or ice-bag.

In the use of cold, care must be taken not to lower the vitality of the tissue by (1) too great a degree of cold or (2) too prolonged an action.

> **It is only in the early stages of inflammation that cold is likely to be suitable.**
>
> **If the inflamed area is the least dusky in colour, cold is almost certain to be injurious.**

Cold in the form of a local bath would be suitable for hand, or hand and forearm, or foot, or foot and part of leg. It must be noted, however, that, except in the case of the hand, it would be impossible to keep the part raised during the bath, and this is a disadvantage. The water employed should be 60° Fahr. and the duration not more than half an hour. The part should then be gently dried and lightly covered, and the local bath repeated in an hour or two, if comfort has been produced by it.

Cold Compress is made of a piece of linen, old and thin, two-fold, and of appropriate size. The person lying in bed should have the clothes so arranged that the inflamed part only is exposed, the surrounding clothes being protected from wetting. A thick folded towel should be placed beneath the part to receive any drip, and it would be well also that this towel should rest on a layer of waterproof.

The linen should be dipped in water at 55° Fahr. and closely applied to the inflamed surface, and it should be so steadily and regularly renewed that it has not time to get warmed. If this is not carefully attended to, the cold cloth becomes converted into a warm fomentation, and the inflamed area becomes irritated rather than soothed. Two pieces of linen should be prepared, therefore, one lying in the basin of water while the other is applied, and with absolute regularity one is replaced by the other. The water in the basin can be kept at the proper temperature by means of a piece of ice.

The Cold Drip is a method of keeping the linen compress saturated with water at the required temperature without constant removal and reapplication. A jug of water, kept at the requisite temperature (55° Fahr.) by means of a piece of ice, is suspended just above the level of the patient's bed, and as nearly over the inflamed part as possible. A piece of lamp-wick or a long strip of lint, or narrow piece of gauze, is placed with one end in the jug and the other resting on the linen compress. The end in the jug should be weighted to keep it at the bottom of the jug; and the height of the jug above the compress will determine the rate at which the water will travel along the wick or gauze to the compress. The bed must be so arranged, and thick folded towel or a piece of waterproof so arranged, that the water flowing off the compress is directed to a bucket at the patient's bedside, without further wetting the patient. This is rather difficult to do. It should also be noted that the wick or gauze should touch the compress, so that the patient is not annoyed by the drop, drop of the water from above. It should just ooze silently and imperceptibly over the compress.

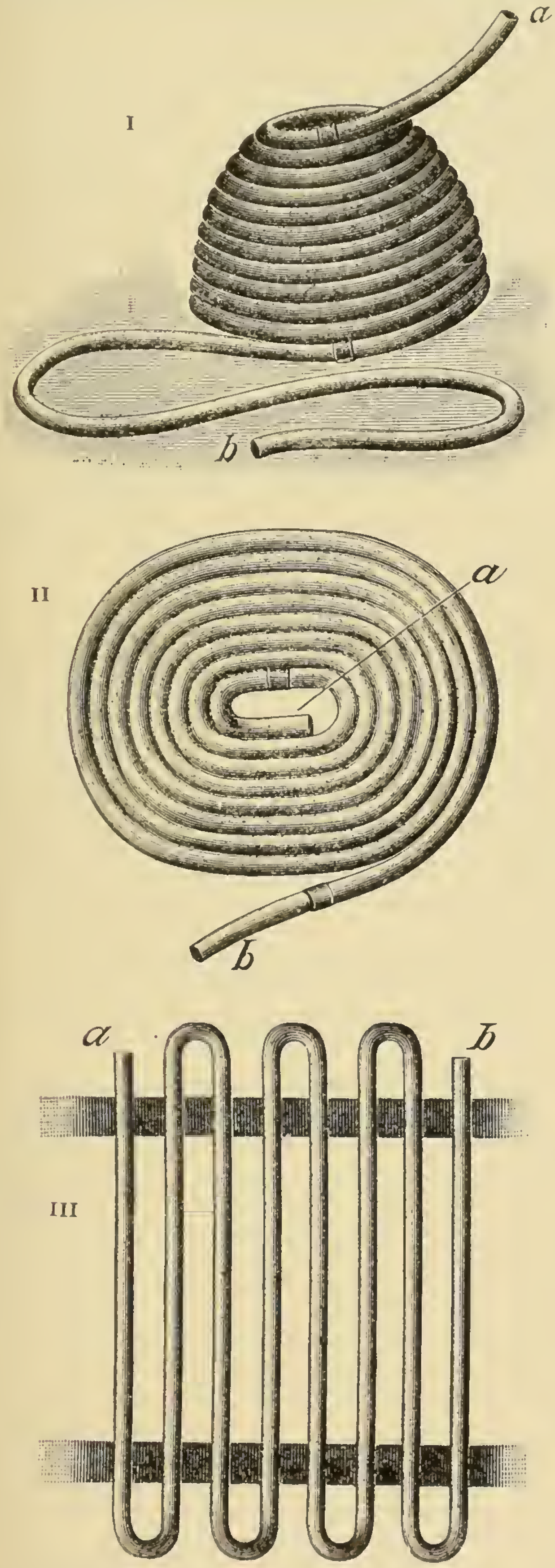


Fig. 147.—The Rubber Tubing coiled in various ways to form a Cold Coil for (I) head, (II) and (III), other parts of the body. The end of the tube in each case are marked *a* and *b*.

The Cold Coil gets over the difficulty of maintaining a stream of cold water over an inflamed region without risk of wetting bed or patient. It consists of narrow rubber-tubing, coiled into a circle or other figure of appropriate shape, and secured by tapes or by being fixed to a piece of cloth. Fig. 147 shows several shapes. Such temperature regulators, as they are also called, may now be bought of instrument-makers, made of light metal, also made in flexible metal, and of different shapes to suit various parts of the body. One end dips into a vessel, placed at the side of and higher than the patient's bed, or suspended above the bed, containing the water of the suitable temperature, the other end dips into a vessel at the bedside. A tap can be fitted to regulate the rate of flow. The application of such a coil to the head is shown in Fig. 148. A wet compress is first applied to the inflamed area, as described (see Cold Compress), and then the coil is laid on it to maintain the low temperature. In Fig. 148 the wet compress is shaped to the head and the coil covers it.

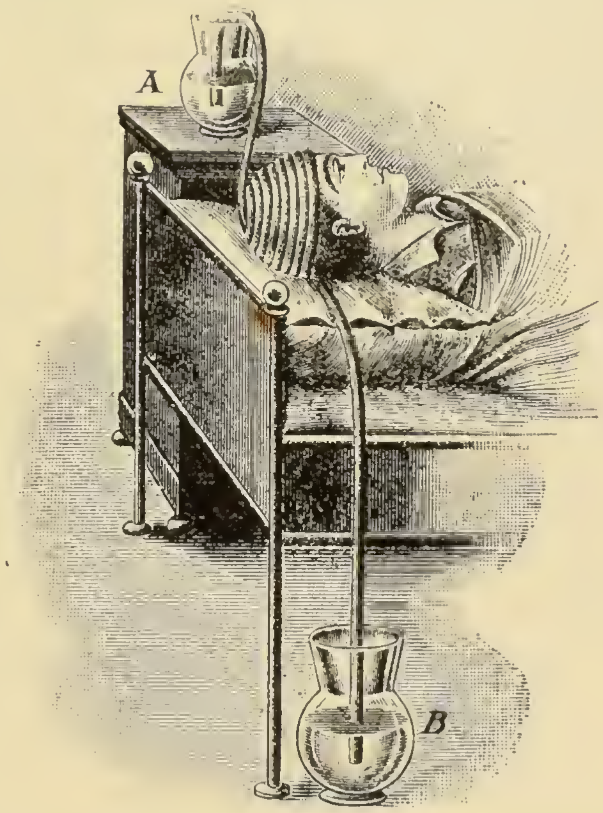


Fig. 148.—The Cold Coil applied to the Head. (A) inlet; (B) outlet of water.

Anyone might make for himself such an apparatus out of an ordinary bladder and rubber tubing. The bladder should have tied into it two pieces of glass tubing, one at each side; to each of these should be attached a rubber tube, one connected with the vessel above and the other dipping into a vessel at the bedside, and water is allowed to flow through the bag; the outlet can be contracted, even by means of a piece of string, so as to regulate the flow.

The Ice-bag consists of a thin bladder, or rubber bag, only half-filled with ice broken small. It is laid over the wet compress, and will remain cool until every piece of ice is melted. It should be replenished before this is quite accomplished.

Cooling Lotions, of which one of the chief is the lead lotion of the druggists, or the lead-and-opium lotion, may be employed, but are not used so frequently as they used to be. A strip of lint is soaked in the lotion and is laid over the inflamed part. The lint is not covered over, but left uncovered, so that the evaporation of the lotion maintains the cooling effect.

Heat is another external application, employed in conditions where cold would be hurtful.

> As a rule, heat is more suitable in the later stages of inflammation, when the irritated area is of depressed vitality, has lost its bright hue, and looks purplish.

When suppuration has begun, heat promotes and accelerates it. Also, when the inflammatory symptoms have abated, heat stimulates the processes by which swelling subsides and thickenings are removed.

The hot Fomentation is the best example of heat application. It is made of a piece of flannel—8-fold—or two pieces of old blanket, of size and shape to suit the inflamed part. Under the inflamed part is laid a folded blanket, if the fomentation is to be applied to the trunk of the body, or a suitable piece if the application is to be only to a limb. The centre of a thick towel is laid in a basin, the piece of flannel upon it, and then boiling water is poured on till the flannel is thoroughly soaked. The ends of the towel hanging out of the basin are now taken up by two persons, one at each end, and, twisting in opposite directions, they rapidly wring out the hot water till the flannel is as dry as it can be made. The hot flannel is now slipped out of the twisted towel and laid closely over the inflamed region, one end of the blanket placed beneath it is then brought up and folded closely down over it, and the other end is similarly tucked round. The fomentation is left on for 20 to 30 minutes. It may be repeated as frequently as comfort requires. The first application should not be so hot as succeeding ones; the first one should rather be employed as a means of preparing the part for a warmer one to follow. When the fomentation is removed, the part is dried and covered.

A Poultice (p. 18, Vol. II.) may be employed instead of the fomentation. It would be made of bread, or bran, or linseed-meal, and charcoal might be added if the surface was raw and foul, or the water with which the poultice is mixed might contain carbolic acid (a teaspoonful to ½ pint of water), or lysol (15 drops to ½ pint of water), or boric acid (½ oz. to the ½ pint).

Inflammations of Internal Parts are treated on essentially similar principles, but it is not so easy to apply the detail or to explain it in a general way. But the general directions given for the treatment of external parts are equally applicable here. These general directions were to remove, if possible, the cause of the inflammation, to keep the part at rest, and to raise it. Now, in the case of inflammations of internal organs, the discovery of the cause is often the most difficult task of medicine or surgery, but the sufferer will often have a fair enough guess at some likely reason for his attack. At least he ought to know whether his indulgence in eating or drinking or some variety of excess is related to his attack, whether his catarrhal inflammation of stomach or bowel, his gouty affection of kidney or throat, his rheumatic or gouty inflammation of joint has followed on some excess he can identify. The removal of the cause in such cases means abstinence from excess of every kind.

It means also emptying stomach and bowel of offending material and cleansing the blood of excessive waste substances. See the discussion, from this point of view, on p. 49.

Rest as applied to hand or foot most people understand, but as applied to stomach or heart or kidney few appreciate what it implies. In the case of the stomach it means the reduction of food to the smallest possible amount, of the simplest kind; in the case of the kidney it means giving such food as will give the least trouble to the kidney in expelling its waste substances; in the case of the heart it means placing the body in such a position as will enable the circulation to be carried on with the greatest ease, and avoiding everything that would quicken its rate by a single beat per minute.

This, put shortly, means rest in bed, in the position most suitable to the particular organ attacked.

In the case of internal organs, also, one may often modify the inflammatory process by external applications of heat or cold. In such cases, however, the body in general is disturbed, and this disturbance is manifested by heightened temperature and quickened pulse and breathing; in short, a state of fever is established. So that the treatment of inflammations of internal organs is on the lines of the general treatment of fever, modified by circumstances due to the particular organ attacked. We need not, therefore, further discuss internal inflammations in this place.

DROPSY

In the discussion of the features of inflammation, continual reference has been made to the cells that escape from the blood-vessels of the inflamed region and to the fluid which exudes from the over-full vessels. To these circumstances, it has been pointed out, is due in large measure the swelling that occurs in an inflamed area. It has also been pointed out that when the inflammation affects the membrane lining any of the closed cavities of the body, a joint cavity, for instance, the pleural cavity, and so on, the exuded fluid may be in large quantity and may accumulate, distending the cavity, in which case it may be called a dropsical effusion.

In such cases the excessive effusion is due to the active determination of blood to the part because of inflammation.

But there are numerous cases where effusion takes place from the blood-vessels, which are over-full, not because of an active determination of blood to the part, but because of some obstruction to the onward flow. The blood comes to the part in ordinary quantity, but does not get away, because of some block to the onward flow.

This, therefore, seems a suitable place to explain all the circumstances in which dropsical effusions may occur.

Dropsy is an accumulation of fluid which has oozed out from the blood-vessels in the minute spaces in the tissue, or in some of the cavities of the body, the cavity of the belly for example.

It is called by a variety of names, according to the position of the accumulated fluid.

Dropsy confined to the tissue under the skin, in the foot, leg, or arm, for example, is called **œdema** or **anasarca**.

Dropsy of the belly is **ascites** (p. 266). The accumulation of fluid round the lung in pleurisy, to which the phrase **pleural effusion** is applied, (p. 359), is a dropsy, and a similar collection round the heart is called **hydropericardium** or dropsy of the heart (p. 318).

On p. 278 it is explained that fluid is constantly oozing from the finest blood-vessels into the tissues to nourish them, that more fluid oozes than is necessary, and that the excess is picked up mainly by lymphatic vessels, and afterwards returned to the blood. Now, suppose more fluid escapes than can be picked up by the lymphatics, or suppose the absorbing vessels are somehow prevented fulfilling their purpose, the excess of fluid will remain and accumulate in the tissues, and in a short time that part will be the seat of dropsy.

Causes of dropsy are thus readily understood. The quality of the blood may be so altered that fluid passes out very readily and in great excess. This happens in anæmia (p. 313), and in Bright's disease of the kidney (p. 399). Again, where obstruction exists to the return of blood to the heart, the blood accumulates in the veins; there is greater pressure on the blood, causing more to pass out of the vessels, and preventing also its absorption, and so dropsy again results.

This obstruction may be merely local. A tumour pressing upon the main vein of a limb will thus produce dropsy limited to that limb. In pregnant women the pressure of the enlarging womb on the veins frequently causes swelling of the legs.

Dropsy may be more general. Thus in certain diseases of the liver the circulation is obstructed, and since all the blood from the belly and the lower limbs passes through the liver the obstruction is experienced in all these parts, and dropsy of both legs and of the cavity of the belly will soon ensue.

A more general cause even than this, and more common, is heart disease, where the onward movement of the blood is hindered by some valve affection (p. 320) causing accumulation of blood in the veins of lungs, liver, and other parts, and occasioning extensive dropsy. In such cases the parts at the greatest distance from the heart, and in the lowest situations, will feel the pressure of blood most, and will show the evidence of dropsical swelling soonest and most markedly, for example the feet and legs.

The same condition may be produced even when no real affection of the valve exists, if the heart is so feeble that it does not contract with sufficient vigour to cause a steady and regular circulation of the blood. The walls of the heart, yielding too much to the pressure of blood within them, may stretch unduly, and thus the heart becomes dilated and thin-walled in proportion to the degree of stretching. Under these circumstances the circulation is sluggish, and in time the blood in the veins experiences a backward pressure, which causes an undue amount of fluid to pass out into the tissues, and dropsy ensues. In these circumstances the swelling appears first in the feet and legs.

It must not, however, be thought that swelling of the feet and legs is in every case caused by something wrong with the heart. Many people are troubled with swelling of the feet and lower parts of the legs after standing long or going about a good deal, the swelling usually disappearing after a rest in bed. This does not necessarily imply any particular disease. When a person stands, the weight of the column of blood in the veins of the legs is considerable, and if the vessels be relaxed in any degree the vessels widen unduly, and the movement of blood is slower than usual, allowing a greater oozing of fluid than can be quickly removed.

In pleurisy, dropsy of the heart, and similar instances, the accumulation of fluid is due not to obstruction to the return of fluid, but to an active determination of a much greater than ordinary quantity of blood by the acute inflammation going on.

The **treatment** of dropsy depends on the cause.

In cases where the dropsical effusion is due to an inflammatory process, the treatment of the dropsy is bound up with the treatment of the inflammation. Sometimes, however, the effusion is so great, as it may be in pleuritic effusion and dropsy of the heart, as to cause grave embarrassment, which cannot, without risk, be permitted to continue. In such cases some, if not all, of the fluid may be removed by **tapping** or **aspiration**.

In cases where the cause is not an active inflammation but some retardation of the onward flow, the organ responsible must be discovered; the state of the liver should be corrected if possible, the weak heart strengthened, &c.

Drugs are employed for the purpose of removing from the blood and casting out of the body a larger amount of water than usual, and so encouraging the picking up of the dropsical fluid into the current of the circulation. Active purgatives, which cause large evacuations of watery stools, do this, such as jalap and elaterium. Other drugs effect the same thing by promoting an increased flow of urine, such as nitre, gin, spirits of juniper, and digitalis. Profuse sweating by means of hot-air baths aids in a similar way. Digitalis is a very useful drug, since it both strengthens the heart and promotes the action of the kidneys. It is in cases where the dropsy is due to some condition of the heart that digitalis proves most valuable. By its strengthening action on the heart it causes more vigorous contractions and tends to restore efficiency to the circulation. But the employment of these means is always attended with risk, unless used by those who really understand the cause of the dropsy and adapt the remedy with care to the circumstances of the case. Therefore the treatment needs determination by a physician.

In cases of dropsy depending on kidney disease, the avoidance of salt, both in the cooking and eating of food, and the use of foods in the constitution of which salt is in small quantity, produces frequently excellent results.

SECTION XVI.

THE AIR-TUBES AND LUNGS (THE RESPIRATORY SYSTEM).

ITS STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Apparatus of Breathing:
- *The Windpipe* or *Trachea*—the larynx and epiglottis;
- *The Bronchial Tubes;*
- *The Lungs*—their air-cells (*alveoli*)—their investing membrane (*pleura*) — their blood-vessels — their position in the chest;
- *The Diaphragm.*

The Movements of Breathing:
- Their *nature*—inspiration and expiration; their *rhythm* and *rapidity*;
- Their *cause* in ordinary quiet breathing and in forced breathing;
- *Varieties of breathing*—abdominal or diaphragmatic, costal, and facial breathing;
- *Results of the movements*—the introduction of air into the chest—tidal, complemental, supplemental, and residual air—vital capacity of the chest;
- *The nervous control* of breathing.

The Purpose of Breathing:
- *The gases of the blood;*
- *Exchanges between the blood and the air* in the lungs—diffusion of gases;
- *Exchanges between the outside air and that of the air-cells*—composition of air breathed in and of air breathed out—amount of oxygen consumed in the lungs daily and amount of water and carbonic acid gas given out.

Ventilation:
- *Its necessity;*
- *Results of improper ventilation*—asphyxia.

Artificial Respiration:

Modified Respiratory Movements:
- *Coughing; Sneezing; Sighing; Yawning; Hiccough; Laughing; Crying; Sobbing.*

Voice:
- *The Organ of Voice*—Larynx, Thyroid, Cricoid, and Arytenoid Cartilages—Vocal Cords;
- *The Production of Voice*—Loudness, Pitch, and Quality of Voice;
- *Speech*—Vowel and consonantal Sounds.

The lungs are the organs of respiration, that is, of breathing. Everyone knows that the continuance of the acts of breathing is necessary to life, and that if respiration be suspended, as it is in choking, strangling, drowning, &c., for even a few minutes, death results. The vast importance of this bodily function, and the great and constant danger of any disease that seriously interferes with its due performance, will be fully appreciated if a general statement of the position it holds in the processes of life be here given by way of introduction to this section.

At the beginning of Section XIV it is stated that a particular order has been followed in the consideration of the various organs of the body, so that any one who chooses to read the sections dealing with structure and functions, one after another in their order, may have a general idea of the whole living human machine.

Section X. discusses the means by which food is prepared to form part of a nourishing fluid —the blood,—and also describes other sources of blood-forming material. Section XIV. follows out the same line by describing the nature of the blood and the means by which it is distributed throughout the body. It points out also (p. 296) that the purpose of the blood is to nourish each minutest element of the body, to give to it raw material for its use in growth and activity, and that it not only gives up to tissues something to maintain them, but acts as a means of carrying away from them the products of their activity, waste substances which, if allowed to remain, would impair their health and vigour, and that thus the blood becomes impoverished as much by poisonous materials added to it as by nourishing materials taken from it.

Now the sources of new nourishment to the blood are all carefully considered in Sections X. and XII., with one exception, that of oxygen gas; but none of the means by which poisonous waste matters cast into the blood are removed has yet been considered.

The lungs supply the oxygen, and on this ground must be considered as organs of blood formation. But at the same time that they supply oxygen, and by the same method, they remove from the blood carbonic acid gas, and that gas is one of the principal waste substances. On this ground, therefore, they rank as blood purifiers. If, then, the lungs are seriously interfered with, a twofold blow is dealt at the blood—the very stream of life,—for the risk at once arises of its supply of oxygen being diminished, without which it is unable to nourish the tissues; and the risk also arises of the carbonic acid being allowed to remain, whose presence renders it poisonous to the tissues. With the consideration of the lungs, then, we complete our view of the sources of supply to the blood, and begin our view of the means of its purification.

THE APPARATUS OF BREATHING.

(Refer to Plates XIX., XX.)

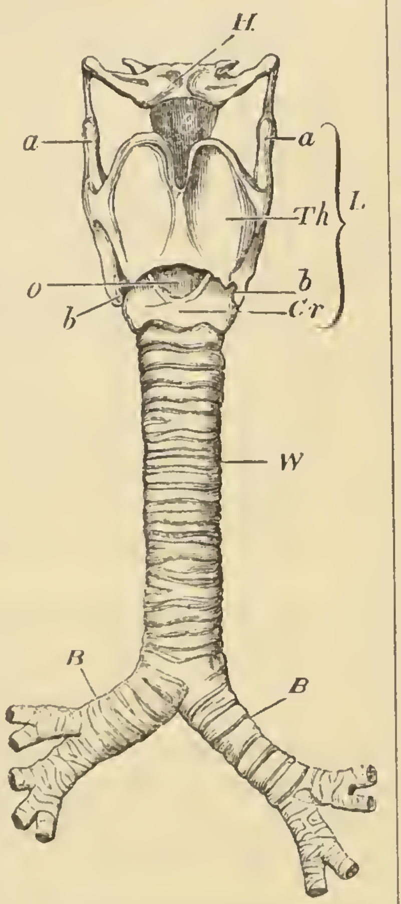


Fig. 149.—The Larynx and Windpipe.

L, larynx, formed of *Th.* and *Cr.*, thyroid and cricoid cartilages. *a*, *a*, *b*, *b*, processes or horns of thyroid (see p. 354). H, hyoid bone. *e*, epiglottis. W, windpipe. B, B, bronchial tubes.

The Windpipe or Trachea.—The lungs may for the moment be regarded as sacs situated in the chest, which communicate with the outside by means of a series of tubes. The chief of these is the trachea or windpipe, which passes down the front of the neck into the chest. It is about 4½ inches long. It is surmounted by the **larynx** (*the box of the windpipe*), a box-like structure made of cartilage (gristle), which contains the organ of voice, to be described later in this section. The larynx may be felt projecting at the upper part of the neck, and in some people it visibly projects. The projection is called the **pomum Adami, Adam's apple.** The upper end of the larynx opens into the pharynx or throat, and is provided with a lid—the **epiglottis**—which closes the opening under certain circumstances. The parts will be understood by referring to the accompanying figure, which represents the larynx and the windpipe. L is the larynx, formed mainly of two pieces of cartilage, called the **thyroid** (*Th.*) and the **cricoid** (*Cr.*). A little below *Cr.* the larynx passes into the windpipe. *e* of the figure points to the tongue-shaped epiglottis, shown raised, but when lowered capable of covering over the upper opening of the windpipe. Now let the reader refer to Fig. 101, p. 195, and the relation of these to surrounding parts will be understood. On that figure *ep* points to the epiglottis; the line pointing to *g* is a little below the level where the larynx passes into the windpipe (*w*). It will be seen also that the larynx opens into the back of the throat, the opening being guarded by the epiglottis, and that the gullet (*g*) is just behind the windpipe Further, it will be seen that the finger, placed on the skin where the turn is made from under the chin on to the front of the neck, will touch the upper edge of the larynx, and that this is below the root of the tongue. Before air can enter the trachea, then, it must pass through the mouth or nostrils (still refer to Fig. 101) into the pharynx (*ph*), past the raised epiglottis, through the larynx, and so into the trachea. Now it will at once occur to anyone that if air can enter into the larynx or windpipe, so can water, or anything one may be drinking, or, for that matter, anything one may be eating. This accounts for food or drink, or things being held in the mouth, a coin, &c., slipping accidentally into the windpipe. But why does this happen only accidentally? Why is it not a constant occurrence? Let anyone put his finger on the front of the neck, on the notch at the top of the larynx, and then let him swallow. He will feel the larynx suddenly lifted up, and, when the swallowing is over, drop down again. By this action the larynx is raised up to be under cover of the root of the tongue, and at the same time the epiglottis folds down. These movements are effected by nervous action, and it is only accidentally, when the parts are taken unawares, as it were, that anything can drop into the larynx or windpipe. The position of the gullet behind the windpipe explains how a mass of food that has been swallowed, and has stuck in the gullet, by pressing on the windpipe in front, produces the sensation of choking, though there is no difficulty in breathing.

The Bronchial Tubes.—The lower end of the windpipe is situated in the chest, and there it divides into two branches (Fig. 149), one of which passes to each lung. Each branch is called a **bronchus** (Latin, *bronchus*, a windpipe), and is called right or left as it passes to

PLATE XIX

THE TOPOGRAPHY OF THE LUNGS

FRONT VIEW

The General Description on Plate XII should first be read, explaining the value of the surface and bony landmarks.

The plate shows the area, blue stippled, occupied by the lungs, and how only a small portion of the heart (red) is uncovered in front by a bay formed in the middle line of the left lung.

R.L. is right, and L.L. left lung; D. is diaphragm; St., breast-bone and its termination, En.; U. is navel; Cl., collar-bone; 1, 2, 3, &c., the numbers of the ribs; W. is windpipe.

The plate shows how each lung comes to a conical point or apex at the side of the neck, and above the level of the collar-bone, the right being a little higher than the left. It shows how the line indicating the front border of the lung gradually approaches the middle line, till the lungs almost touch one another at the level of a line across the breast-bone joining the cartilages of the 2nd rib of each side. The plate indicates how from this point the border of the right lung runs downwards pretty straight, till it reaches the place where the cartilage of the 6th rib joins the breast-bone; here the border of the right lung passes outwards as well as downwards, till at the side of the chest it reaches the 8th rib.

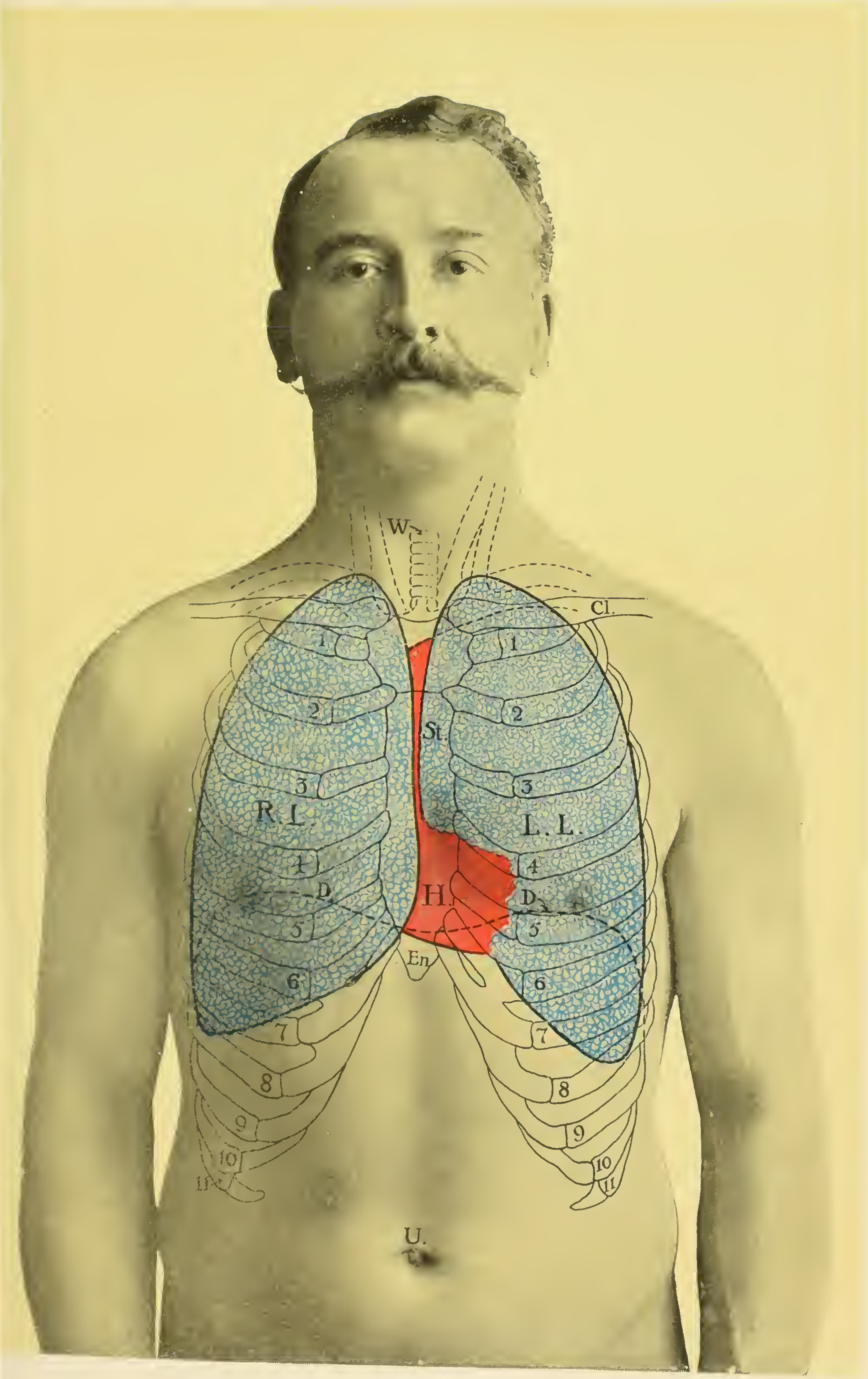
The left lung, on the other hand, slopes outwards from the place where the cartilage of the 4th rib joins the breast-bone, to the space between the 5th and 6th rib where the apex of the heart lies (see Plate XVI), uncovering a part of the heart. The part of the heart thus uncovered by lung is the right ventricle.

The border of the left lung then sweeps downwards and outwards by the right, but reaches a little farther down than the right, about the breadth of a rib.

On the chest wall, then, one can easily mark in chalk the limits of the lungs.

There is a membrane which lines the lungs—the pleural membrane (see p. 344). This membrane extends somewhat lower than the actual lung margin, and in the middle line in front the membrane of one side meets that of the other, merely coming into contact, not merging.

PLATE XIX



THE TOPOGRAPHY OF THE LUNGS

(FRONT VIEW)

the right or left lung. The place where the tube enters the lung is called the root of the lung. Each bronchus, after passing into the lung, divides into smaller tubes, and these again into still smaller, and so the division and subdivision go on till the whole lung is penetrated by branches, the final subdivisions of which are of extreme fineness. To all these divisions and subdivisions the general term **bronchial tubes** is applied. The smallest of them are only about the $\frac{1}{50}$th of an inch in diameter. Fig. 150 represents A, the windpipe, branching into B, the left, and C, the right bronchus, and these into smaller bronchial tubes, such as D. This figure is, however, only a representation, for the multitude of tubes of extreme fineness into which the larger tubes ultimately break up cannot, of course, be shown, though some attempt is made to represent them on the side on which B is placed.

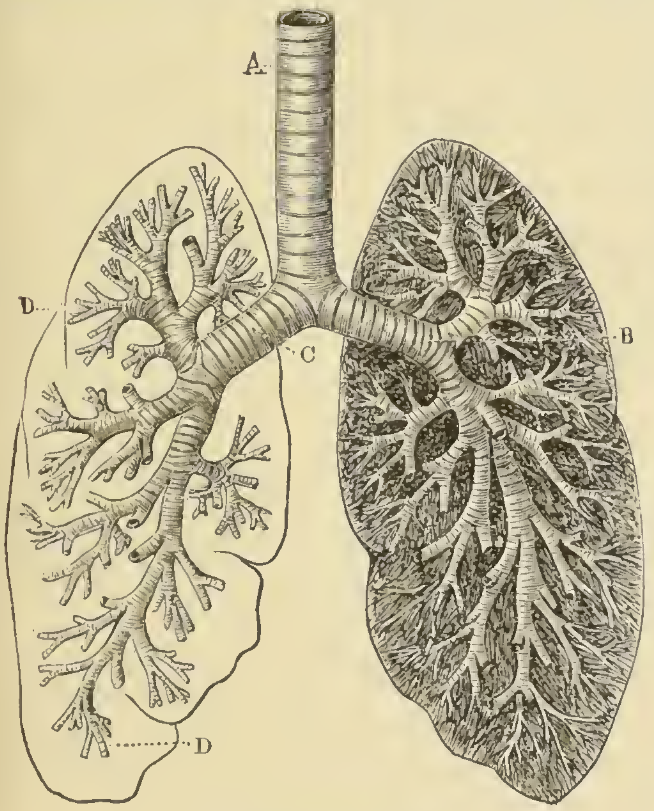


Fig. 150.—Bronchial Tubes.

Now there are some remarkable features worth pointing out in the structure of the windpipe and bronchial tubes. Unless some provision was made to the contrary, the tubes, even the largest of them, would readily collapse, their walls would fall together with the slightest pressure, and the fair-way for the passage of air would be closed. The walls are, however, stiffened by pieces of cartilage (gristle). In the windpipe the pieces of cartilage are C-shaped, the deficient part being behind, resting on the gullet. In Fig. 149, W points to one of the cartilaginous rings, and in Fig. 155 (p. 354) is seen how they terminate behind. In the bronchial tubes plates of cartilage are disposed in the circumference of the walls, and act like the rings of the windpipe, keeping the tubes open. In the smallest tubes, however, the cartilage is absent, and the tubes become liable to spasmodic closure. In the windpipe the defective portion of the rings behind is closed by a band of muscular fibres of the involuntary kind (p. 113), while in the bronchial tubes there is a middle coat formed of a continuous layer of involuntary muscular fibres disposed round the walls. Both windpipe and bronchial tubes have elastic fibres running the length of the tubes. The inner surface is lined by mucous membrane continuous, through the larynx, with that of the throat, mouth, and nostrils. An inflammation attacking the throat is thus apt to travel along the membrane downwards into the windpipe and bronchial tubes, leading to cough, and perhaps to bronchitis. This mucous membrane is covered by layers of epithelial cells, those on the surface being provided with the hair-like processes called cilia, depicted in Fig. 6, p. 54. The mucous membrane is provided with glands, which, by their secretion, keep the membrane moist. These anatomical details are interesting because of the purposes which the structures are fitted to serve. As already pointed out, the cartilage keeps the tubes open. The elastic tissue confers elasticity on the tubes, permits them to stretch readily with the movements of the neck, &c., and to return to their usual condition when the stretching is over. The cilia of the epithelium keep up a constant waving movement, all in the same direction, namely upwards, and thus any excessive secretion or defluxion is gently urged upwards to the top of the windpipe, from which it is expelled by a cough. Material is thus prevented from passing downwards and accumulating in the small tubes, so that they are in ordinary circumstances kept clear. It is believed that the muscular layer, specially of the smaller tubes, acts in a similar way, sweeping upwards by its contractions matter to be expelled. An eminent physician has, on this account, called them "scavenger muscles." It may be mentioned here that this muscular coat, in unhealthy conditions, may by its excessive contraction produce a serious difficulty in breathing. If muscular spasm occurs in the smallest tubes, unprovided with cartilage, it may close the tubes, prevent the passage of air, and so occasion severe difficulty of breathing. This spasm would be produced, among other things, by excessive nervous action, and is believed to be the cause of the difficulty of breathing in nervous asthma. But, again, it should be noticed that if one attempted to breathe an irritating gas the muscular coat would be stimulated to contract, would bar the way to the entrance of the hurtful gas, and so be of great benefit.

It has been noted that the smallest bronchial tubes have no plates of gristle in their walls. They lose also the hair-like processes of the epithelial cells, which are reduced to one fine layer.

The Lungs.—In an earlier paragraph of this section the lungs were, for the moment, represented by two bags or sacs communicating by means of tubes with the external air. This would almost be a proper description of the lungs of some of the lower animals, if we add to it that the sacs have depressions in the inner surface of their walls resembling the cells of a honey-comb. In the lungs of the higher animals and of man the structure is much more complicated, although built up, so to speak, on the type of the elementary structure just noticed. If one of the smallest bronchial tubes be traced to its extremity it is found that it leads into a passage wider than itself, and that from that passage there open out on all sides honeycomb-like cells. This is represented in outline in I of Fig. 151, where *b* indicates the termination of the bronchial tube, *h h h* the passage into which it leads, and *c c c* the cells opening off the passage. The cells are called **air-cells** or **alveoli** (Latin, *alveolus*, a small cavity), and the passage is the **alveolar passage**. The whole arrangement of passage and air-cells springing from the termination of a bronchial tube is called an **infundibulum**, because of its widening out from the place where it arises from the bronchial tube. It is also called an ultimate lobule. II of Fig. 151 shows two such infundibula from the lungs of a newly-born child (magnified twenty times) as they appear when not opened up, as they are in I. Now each such ultimate lobule of a human lung is a very small miniature of the whole lung of some of the lower animals. So that a whole human lung is a kind of assemblage of miniature lungs of the type of the lower forms. For several infundibula are grouped or packed together, and thus form a lobule, larger than the ultimate lobule, from a quarter to half an inch in diameter, and bound by connective tissue. Several lobules are bound together in a similar way to form a lobe of the lung. The right lung has three such lobes, and the left two.

The walls of the air-cells are very thin, consisting of delicate elastic and connective tissue, and lined inside by flat transparent cells. In the connective tissue run capillary vessels belonging to the pulmonary artery and veins (p. 301). Now if Fig. 151, I, is attentively considered it will be seen that these thin-walled vessels running in the connective tissue are surrounded on all sides by air-cells, so that the blood flowing through them is only separated by the thin walls of the vessels, and by the delicate tissue of the air-cells, from the air which these cells contain. The deep significance of this will be apparent immediately.

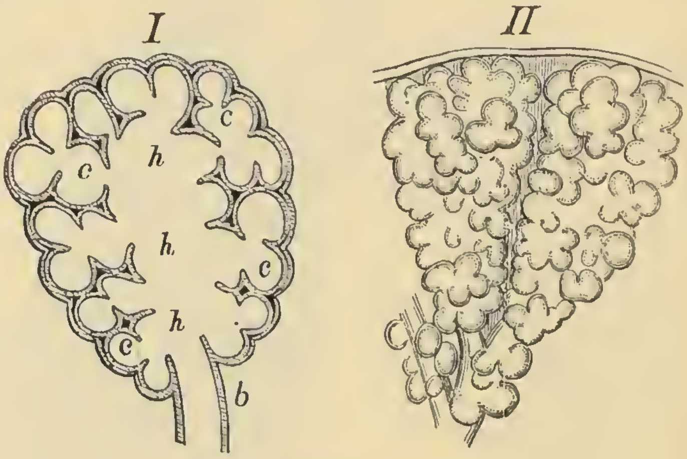


Fig. 151.—Air-cells of the Lung.

It need only be noted now that such an arrangement is perfectly adapted for exchanges taking place between the blood in the capillaries and the air in the air-cells.

Each lung is surrounded by an investing membrane—the **pleura**. Like the investing membrane of the heart (p. 298) the pleura of each lung is in a double layer. One layer closely envelops the lung and at the root of the lung is folded back on to the wall of the chest cavity, of its own side, which it lines. The two layers thus form between them a shut sac, a serous cavity. No cavity exists, however, in health, but the two layers glide on one another, and the inner surface secretes a slight amount of serous fluid to prevent friction. It is inflammation of this membrane that is called pleurisy (p. 359).

Through the root of the lung vessels pass to and from the lung. The pulmonary artery enters carrying blood from the right side of the heart to the capillaries of the air-cells, to be purified by contact with the air the cells contain. The pulmonary veins leave the lung by the root to pass to the left side of the heart, carrying the purified blood. Branches from the great artery—the aorta,—called **bronchial arteries**, enter the lungs at the root, carrying pure blood to be distributed over the bronchial tubes and among the connective tissue of the lungs, to maintain their nourishment. Lymphatic vessels also pass out by the root to join the thoracic duct (p. 278). For lymphatic channels are distributed through the lungs over the bronchial tubes, and are in direct communication with the air-cells. It is by means of the lymphatic vessels that matters are absorbed from the lungs, and afterwards may be poured into the current of the circulation, after passing through glands.

The lungs are also supplied with nerves.

The position of the lungs is shown in Fig. 133 (p. 297). One lung occupies the right side, the other the left. They meet in the middle line, but the lung of the right side reaches farther down in the middle line than that of the left, because a deep notch exists in the front border of the left, into which the heart projects. When both lungs are well filled with air the heart is covered except the portion in the position of this notch. As seen in the figure (133) a line drawn downwards and to the side to the level of the tenth rib, from about the position where the sixth rib joins the breast-bone, will indicate the extent to which the lungs reach downwards. On the left side, however, the lung extends downwards farther than on the right side by the breadth of a rib. On each side the lungs reach upwards higher than the first rib, the top of each lung passing up into the neck on each side for an inch and a half above the level of the first rib. Refer also to Plate XIX.

The Diaphragm.—The base of the lungs rests on the muscular partition—the **diaphragm**—which separates the cavity of the chest from that of the belly. This muscular partition is one of the main agents in the act of breathing, and its position must be understood. It forms the floor of the chest cavity and the roof of the abdominal cavity, just as the roof of one room is the floor of the room above it, and separates the two from one another. It is not flat, however, but arched, the arch being directed upwards. This will be understood by a reference to Fig. 152, which is a section of the body carried from back to front, and shows the cavities of chest and belly, with their contents removed. The diaphragm is also shown in section, arching from B in front. It is seen that it is convex towards the chest and concave towards the belly. It is attached all round to the breast-bone and ribs in front, to the ribs at the side, and to the ribs and back-bone behind, being attached lower down at the sides and back than in front. On its upper surface the base of the lungs rests, the pleuræ being connected with it and the investing membrane of the heart also. This is well shown in Fig. 104 (p. 198), where C points to the diaphragm. It also shows that immediately below the diaphragm, and mainly on the right side, the liver is situated, while mainly to the left side is the stomach. If the liver be gorged with blood—congested,—or the stomach distended with wind, pressure will be exerted upwards, will force up the diaphragm, will prevent the proper filling of the lungs with air, by diminishing the space for their distention, and so will occasion breathlessness. Now the diaphragm, being partly composed of muscle, is capable of contraction. When it contracts, the sides being fixed by their attachments to the ribs, &c., its centre will be pulled on and therefore lowered. That is to say, the floor of the chest will be lowered, the cavity of the chest will thereby be enlarged, and room will be afforded for the expansion of the lungs. On the other hand, when the diaphragm becomes relaxed, its contraction being over, it will rise by its own elasticity, the cavity of the chest will be diminished, and air will be forced out of the lungs to afford room for the rise. As we shall see, it is chiefly by the regular succession of contraction and relaxation of this muscular partition that the movements of breathing are carried on.

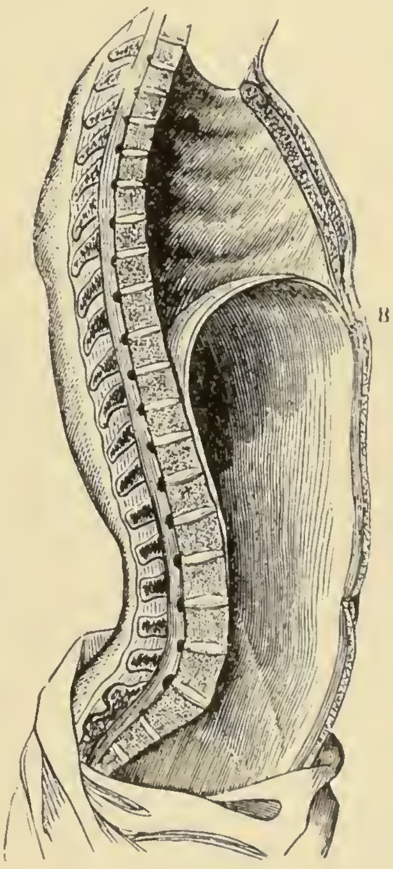


Fig. 152.—The Diaphragm.

THE MOVEMENTS OF BREATHING.

If a healthy person be observed it will be noticed that the act of respiration or breathing consists of a regular series of movements. With the taking in of breath the chest rises and the belly is slightly pushed outwards. That is immediately followed by the falling of the chest, the return of the belly to its former size, and the output of air. Succeeding this is a pause, and the same set of movements is thereafter repeated. The first act is called **inspiration** (Latin, *in*, and *spiro*, I breathe), and the second is expiration (Latin, *ex*, out, and *spiro*, I breathe). What is, therefore, called the **rhythm of respiration** consists of three parts, inspiration, expiration, pause, one after the other in regular order, the three parts forming one respiration. In an adult healthy man the number of respirations should be about 16 per minute, but the number varies with age, that of a newly-born child being 44 (see p. 41). During the time of one respiration there should be about 4 beats of the heart. Besides age, other things affect the number of respirations per minute. Exercise increases the number, while rest diminishes it. The number is smallest during sleep. Mental emotion and excitement quicken the rate; the mere paying attention to one's own breathing affects the rate. Of greatest consequence is the effect of disease. In fevers the rate is increased and the rapidity of the pulse is increased in proportion. In diseases specially affecting the lungs, such as bronchitis, pleurisy, consumption, &c., the rate of breathing is very marked, and usually where the lungs specially are involved, the increased rate of the breathing is out of all proportion to the increased rapidity of the heart. In such diseases there may be as many as 60 or 70 respirations per minute.

The cause of respiratory movements may be made plain by a simple experiment. Let a glass bell-jar with a neck and open mouth be taken (Fig. 153). Let two small india-rubber bags (*b b*) be connected to the end of a glass tube (*c c*), and let them be introduced into the jar, the glass tube passing through a tightly-fitting india-rubber cork. Then let a leather floor (*e*) be fixed to the jar, shaped as shown in Fig. 153, so that it may be pushed up into the jar into the position marked *e*, or pulled down into the position marked *d*. The floor must also be air-tight. Now here we have a chamber (*ch*) entirely shut off from the outside air, and hanging in it are two bags, whose cavities have no connection with that of *ch*, but communicate with the outside air by the tube *c c*. The air in the chamber and the air in the bags are both under the same pressure, that of the atmosphere, a little more than 14 lbs. to the square inch. Now suppose the leather floor to be in the position of *e*; let it be caught by the hand and pulled down to the position of *d*. By this movement the cavity of the chamber is increased in size, and, as it has no communication with the outside, no air can enter to occupy the increased space, and consequently the air already present expands to fill the larger cavity, that is, it becomes rarefied. The result is that the pressure of air in the interior of the chamber is less than it was before. But the pressure of air in the inside of the elastic bags (*b b*) is undiminished, so that the pressure within them is greater than the pressure outside of them, that is in *ch*. In consequence the bags yield to the pressure of air within them, they expand, air entering by the tube *c c*, and they continue to expand until their increased size (shown by the dotted lines *f f*) makes up for the addition to the size of *ch*., until they occupy the increased space. Next let the leather floor be pushed up; the size of *ch* is diminished, the bags are pressed on from within, air is expelled from them, so that they become smaller, and the original state of affairs is restored. Now this is precisely what takes place in the chest and lungs. Let us compare the two things step by step. The chest is a chamber, formed of bony walls, the ribs, connected in front with the breast-bone and behind with the back-bone (see Fig. 20, p. 61). The spaces between the ribs are occupied by muscles—the **intercostal muscles** (Latin, *inter*, between, and *costa*, a rib), while large masses of muscle clothe the chest in front and behind, layers of fat and connective tissue covering them, and the skin being outside of all. The chest has for its movable floor the diaphragm already described. It is an air-tight

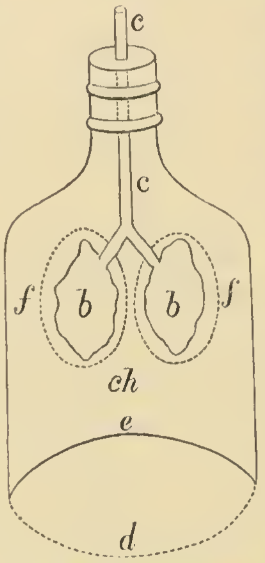


Fig. 153.—The Mechanism of Respiration.

PLATE XX

THE TOPOGRAPHY OF THE LUNGS

BACK VIEW

This plate is meant to indicate, by outline on the back wall of the body, the area occupied by the lungs.

The mottled blue areas are the lungs.

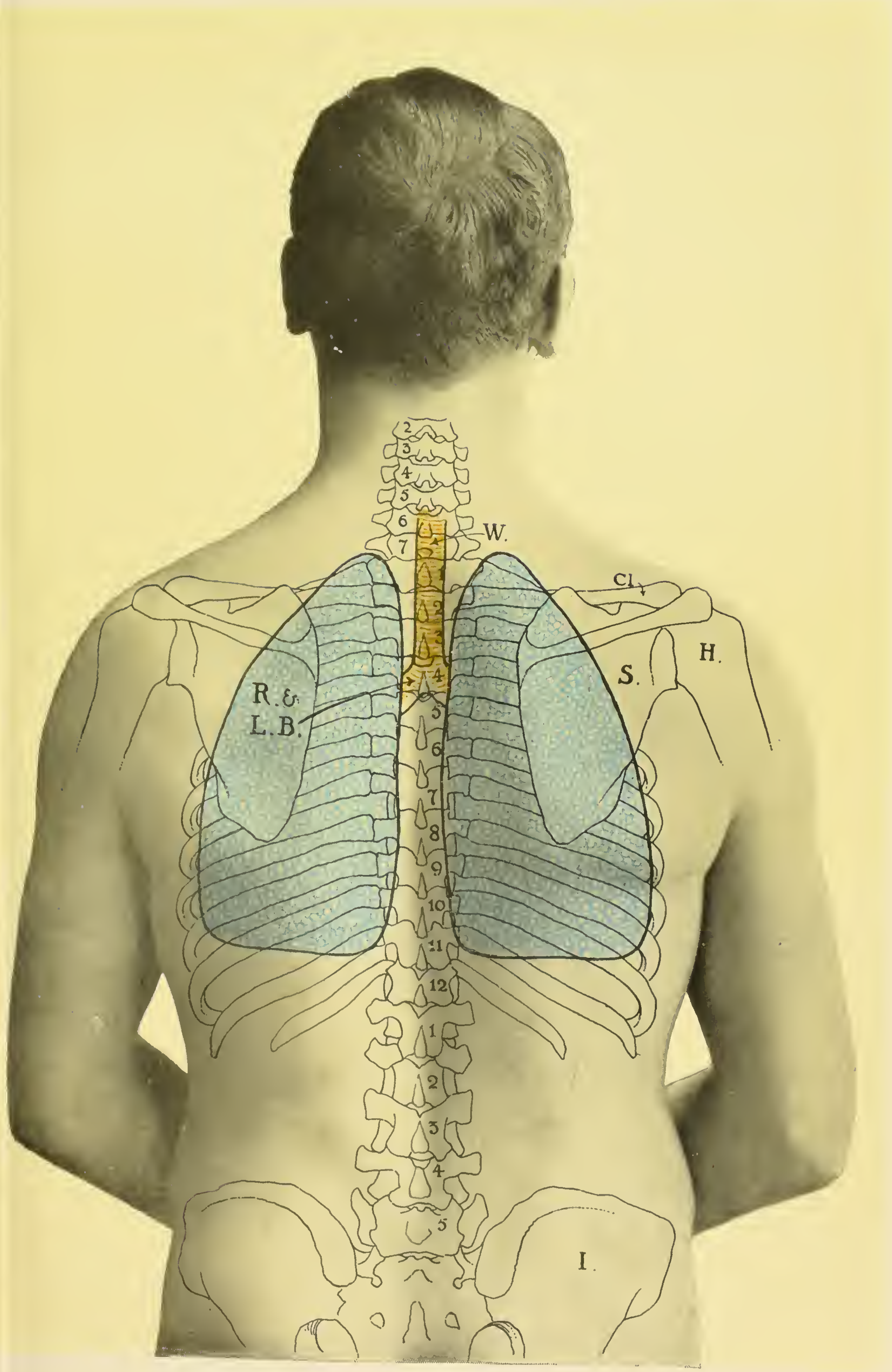
The yellow represents the windpipe (W.) dividing into right and left bronchial tubes (R. and L. B.).

The other figures are as in Plate XIII.

The plate indicates that the apex of the lungs reaches as high as the level of the 7th spine of the neck, that the borders of the lungs in the middle line touch the sides of the bodies of the vertebræ, and that they reach as far down as the spine of the 10th dorsal vertebra. The investing pleural membrane passes even lower than this to the head of the 12th rib.

This plate should be studied with Plate XIX.

PLATE XX



THE TOPOGRAPHY OF THE LUNGS

(BACK VIEW)

chamber comparable in every respect to *ch* of Fig. 153, with this additional advantage, that its walls are movable as well as its floor. It has suspended in it the lungs, whose air-cells communicate with the outside by means of the bronchial tubes and windpipe, but have no connection with the general chest cavity, and which are represented on the figure by the elastic bags (*b b*). This much, however, must be noticed, that the lungs and other contents of the chest completely fill its cavity, and do not simply occupy a small space in it. The contraction of the muscular fibres of the diaphragm causes it to descend, and thus increases the size of the chest cavity. The pressure of air in the lungs is thus made to exceed that in the chest, a quantity of air, consequently, enters the lungs, which expand to fill up the increased space, just as pulling down the leather bottom of *ch* causes the elastic bags to distend. As soon as the contraction of the diaphragm is over, it relaxes, returns to its original position, reduces the size of the chest cavity, and air is expelled from the lungs to permit them to diminish in size. After a short pause the diaphragm again descends by contraction of its muscular fibres, and the round of operations is repeated.

The cavity of the chest is enlarged from above downwards by the descent of the diaphragm, but this is not all. Its walls are also movable. The ribs may be raised by the contraction of the intercostal and other muscles, and by their rising they push forward the breast-bone. The chest cavity is by this means enlarged from side to side and from before backwards. Thus the cavity of the chest is increased in three directions, from above downwards, from side to side, and from before backwards, by the descent of the diaphragm and by the elevation of the ribs. As a result the expansion of the lungs is made more vigorous. This is the cause of the breathing in of air, of *inspiration*, which is seen to be essentially *a muscular act*—the result, that is to say, of a series of muscular contractions. But as soon as the contraction is over, the ribs tend, by their weight, to fall down into their position of rest, the muscles tend to relax, and the lung tissue, which is elastic and has been stretched by the expansion, tends to return to its original unstretched condition, as an elastic band which has been stretched recovers itself as soon as the stretching force is removed. The result is, the original size of the chest cavity is restored, and a quantity of air is expelled from the lungs. So *expiration* is seen to be essentially the result of an *elastic recoil*, and not active muscular contraction. While this is the mechanism of *ordinary quiet breathing*, other forces are brought into play when breathing is difficult, as when the windpipe or bronchial tubes are obstructed, notably as in asthma, where there is spasmodic closure of the bronchial tubes, and in diseased conditions of the lungs, which create an obstacle to their expansion. In such cases many additional muscles are called into play, which contract vigorously for the purpose of pulling up the ribs more completely and compelling the lungs to expand, producing what is called **forced inspiration**. Thus asthmatic people, who are awakened out of sleep by a spasm, instinctively raise their arms to grasp something above the level of the head. This is for the purpose of obtaining a fixed point of support from which muscles, passing from the arms and shoulders to the chest, may act in forcibly raising the ribs. Again, when the output of air is hindered, **forced expiration** results. Breathing out ceases to be the result of a mere elastic recoil, and muscles are called into play, such as those passing up from behind to the lower ribs, whose contraction pulls down the ribs, and those of the abdominal walls, whose contraction presses on the contents of the belly and forces them up against the lower surface of the diaphragm, causing it to ascend.

Varieties of Breathing. — The two main agents in the production of breathing being the descent of the diaphragm and the elevation of the ribs, the movements visible from the outside vary according to the predominance of one or the other.

In men and in children the action of the diaphragm is marked. Its descent diminishes the space in the cavity of the belly, presses on the organs therein contained, and causes an outward movement of the belly walls, so that the movements of its walls are specially noticeable. This is called **abdominal** or **diaphragmatic** breathing.

In women the action of the ribs is more strongly marked, and the chest rises and falls more than in man. This is **costal** (*costa*, a rib) breathing.

Abdominal breathing is well seen in infants. It ought, therefore, to be plain how the common practice of binding children tightly round the belly is extremely injurious, since it interferes with the natural performance of the respiratory act.

These natural varieties of breathing are altered in various ways by disease. A painful disease of the belly will compel a man to prevent movement of the abdominal walls as much as possible, and then the costal variety will take its place, while some disease of the chest will often cause a woman to suspend her natural method of breathing, and to adopt the abdominal form. In this way one is sometimes able to form an idea of the seat of a disease simply by watching the movements of respiration, and observing whether they are of the kind that would be expected in ordinary states of health.

Facial breathing is the term applied to the movements of the nostrils, seen particularly well when breathing is laboured. It consists in an expansion of the nostrils with each inspiration, and a return to their previous condition in expiration. In children with bronchitis, or inflammation of the lungs, it is marked. Indeed whenever it is specially noticeable, unless after considerable exertion, it should call attention to the condition of the lungs.

The result of the movements of respiration is alternately to introduce and to expel from the lungs a certain quantity of air. When a man breathes quietly, 30 cubic inches of air enter the lungs with each inspiration, and 30 cubic inches pass out with each expiration. After taking an ordinary breath a man may, by forced inspiration, by taking the deepest possible breath, introduce into his lungs an additional 100 cubic inches. Again, after breathing out an ordinary breath (30 cubic inches) one may by an effort expel 100 cubic inches more. But even after the utmost expulsive effort 100 cubic inches remain in the lungs which cannot be expelled. The 30 cubic inches that pass in and out in quiet breathing form what is called the **tidal air**. The 100 extra cubic inches one may draw in with effort are the **complemental air**, and the 100 extra cubic inches one may expel with effort after breathing out the ordinary amount form the **supplemental air**. The 100 cubic inches which remain and cannot be expelled form the **residual air**. Thus the lungs of an adult man are capable of containing altogether 330 cubic inches of air, thus composed:—

Complemental air	100	cubic	inches.
Tidal ,,	 30	,,	,,
Supplemental ,,	100	,,	,,
Residual ,,	100	,,	,,
	330		

If, then, a person, after taking the deepest possible breath, proceeds to breathe out as much as he can, he expels—

Of complemental air	100	cubic	inches.
,, tidal ,,	 30	,,	,,
,, supplemental ,,	100	,,	,,

Making a total of 230 cubic inches, forming what is termed the **vital capacity** of the chest, after which there remain in the lungs the 100 cubic inches of residual air. The vital capacity is then determined by the amount of air a person can expel with the utmost effort after taking the deepest possible breath, and ought in a healthy adult man of average height and weight to equal 230 cubic inches. In women it is less than in men. There are various forms of instruments for measuring the amount. They are called **spirometers**, or measurers of breathing, and are some form of what is familiar to everyone under the name gasometer. The vital capacity varies with height and weight, increasing with increasing height above the average, and slightly decreasing with increased weight above the average.

The Nervous Control of Breathing.—The movements of breathing go on without the necessity of any interference on our part, without our consciousness of them being necessary. During sleep their regularity is even greater than when we are awake, and when awake we may alter the movements to some extent, but cannot altogether arrest them. The breath may be held for a time, but speedily the need for breath gets the mastery, and a long deep breath is drawn. Now it has been shown that there is a particular part of the nervous system that presides over the respiratory function. It is situated in the medulla oblongata (p. 150). Destruction of this part is followed by immediate stoppage of breathing and death. On this account this region of the medulla has been called the *vital knot* (*nœud vital*). Here there is, that is to say, a nervous centre for breathing. It is injury to this centre that proves fatal in cases of broken neck. From it regular discharges of nervous activity pass outwards to the nerves that supply the diaphragm and other muscles of respiration, and stimulate them to the regular or periodical contraction which, as we have seen, is the cause of the movements of the chest, the expansion of the lungs, and the entrance of the air. But the centre is capable of being influenced in various ways. Chiefly it is affected by the condition of the blood. When the blood becomes more venous the action of the centre is excited, and more vigorous respiratory movements occur. On the other hand, if a series of very deep breaths is taken, so that the blood becomes more richly supplied with oxygen than usual, a considerable time will elapse before the need of another breath is felt, and after the interval the breathing will be resumed, the first inspiration being feeble, and those succeeding gradually increasing up to the average. The meaning of this is that the presence of the unusual quantity of oxygen in the blood has calmed the respiratory centre, so that for a time it has ceased its regular periodical discharge, till, as the blood begins to become venous, the usual stimulus is restored. This explains how persons may train themselves to remain under water for some time with no arrangements for permitting breathing to go on. They take a series of deep inspirations, take into the blood, as it were, a stock of oxygen sufficient to last for a little time, and before they dive under the surface. The respiratory centre is, then, stimulated by the presence of excess of carbonic acid in the blood, and soothed by the presence of excess of oxygen. It is the great excess of carbonic acid present in the blood, in cases of continued obstruction to the breathing, that produces the excessive stimulation of the centre, indicated by laboured breathing and the convulsions of suffocation. The centre may, however, be stimulated in other ways. Nerves of sensation supplying the general surface of the body are capable of conveying influences to it leading to its excitement, and ending in vigorous respiratory movements. Thus cold water dashed on the face or chest, a sudden draught of cold air on an exposed part of the body, &c., are speedily followed by a deep, long-drawn breath. The cold water or air has irritated sensory nerves, and the stimulus has been conveyed to the centre, producing a discharge of nerve force to the muscles of inspiration. This fact is of common application in cases of fainting; and newly-born children who show some delay in beginning to breathe are roused to the performance of this function by rapid rubbing of the sides with the fingers, by dashing a small quantity of water on the bare chest, or by blowing on the face, all of these methods exciting sensory nerves. The action of the respiratory centre may also be modified by influences from above—from the brain,—by mental emotions, for example. One nerve in particular conveys impressions to the centre for respiration, affecting through it the movements of breathing. It is the **pneumo-gastric** or **vagus** nerve (p. 152). Some fibres of that nerve end in the lungs, and thus from the lungs themselves, in some way not yet understood, influences pass upwards to the centre of the medulla oblongata which affect the respirations. By means of that nerve the centre is kept informed, as it were, of the condition of the lungs themselves.

Even as the oxygen and carbonic acid gas in the blood directly act on the centre, so drugs that have been taken and have passed into the circulation may act on it. Notably does morphia influence it, markedly reducing its activity. In morphia poisoning it is maintenance of breathing that must chiefly be attended to.

THE PURPOSE OF BREATHING.

We must now try to understand what is the object of the remarkable and complicated structure of the lungs and of the movements which have been described.

The Gases of the Blood.—On p. 295 it has been shown that the blood contains three gases, oxygen, carbonic acid gas, and nitrogen, partly dissolved in it, partly in chemical union with certain of its constituents. The nitrogen need not be taken into account. The oxygen is to be considered as part of its nourishing material, which the tissues, to which the blood is distributed, require to carry on their processes. The carbonic acid gas is a waste substance which the tissues produce by their activity, and which the blood carries away from them. As the blood flows through the body its oxygen is removed from it, carbonic acid gas being substituted; and if the efficiency of the blood to nourish the tissues, in this respect, is to be maintained, it must always be receiving new supplies of oxygen, and a means must be at hand of ridding it of its excess of carbonic acid gas. This double function it is the business of the respiratory process to perform. The blood that is sent out from the left side of the heart, on its mission to supply the body, is of a bright scarlet hue (the colour of arterial blood), while the blood that returns to the right side of the heart, after its mission is accomplished, is of a dark purple colour (the colour of venous blood). This change in colour takes place in the capillaries, the vessels whose walls are so delicate as to permit of free interchange between the blood in the vessels and the tissues outside of them. In short, it is due to the fact that in the capillaries the blood gives up its oxygen to the tissues, and receives from them carbonic acid gas. This is proved by chemical analysis, which shows that arterial blood contains more oxygen and less carbonic acid than venous blood,[1] and by the experimental fact that if the dark-coloured venous blood be shaken up with oxygen it becomes of a scarlet colour, while arterial blood shaken up with carbonic acid gas becomes purple. Now, as mentioned on p. 302, the venous blood, returned from the body, is conveyed to the right side of the heart, and thence by the pulmonary artery to the lungs, through which it is distributed in capillary blood-vessels to be gathered up into the pulmonary veins and carried to the left side of the heart. But when it leaves the right side of the heart the blood is purple-coloured, and when it enters the left side it is scarlet. That is to say, while passing through the capillaries of the lungs it has been converted from venous into arterial blood. In other words, in its progress through the lungs it has given off its excess of carbonic acid gas and obtained a new supply of oxygen. So that while in the general capillaries of the body the blood is rendered impure by being deprived of much of its oxygen and being laden with carbonic acid, in the capillaries of the lungs the process is reversed, and the blood is purified by being rid of its excess of carbonic acid and by having its proper quantity of oxygen restored. Now it has been already stated (p. 343) that the capillaries of the pulmonary artery, through which the blood flows on its way from the right to the left side of the heart, are distributed over the walls of the air-cells of the lung, and that the air-cells are so numerous and closely packed, and their walls, as well as those of the capillaries, so thin that there is no obstacle to an interchange taking place between the blood in the vessels and the air in the air-cells. It is manifestly here, then, that the change occurs which transforms the dark-coloured, carbonic-acid-laden venous blood into the bright-hued blood refreshed with oxygen. How does that conversion occur is the next question.

Exchanges between the Blood and the Air in the lungs. It is a well-known physical law that if two different liquids be placed in a vessel in contact with one another, and be left alone, without any disturbance whatever, they do not remain separate, but proceed straightway to mix, and in time there will be a perfect mingling of the two liquids. Suppose, for example, that water and spirit are taken, and, for the sake of seeing the experiment going forward, that the spirit is coloured red, that the water is placed in a glass jar, and when it is perfectly still that the spirit is carefully poured on the top of it, so carefully that the two layers, one below of colourless water and the other above of coloured spirit, are quite distinct from one another. If the jar be set aside, it will be observed that the coloured spirit does not long remain all on the top, though it is lighter than water, but that the colour gradually passes downwards into the water, until in time the whole is coloured—an equal mixture of water and spirit is found in the jar. This is called **diffusion of liquids.** Now the same thing occurs with gases though the process is not visible. If one glass jar be filled with carbonic acid gas and a second with oxygen gas, and if the jar containing the oxygen be placed upside down on the top of the jar containing the carbonic acid, the jars being fitted mouth to mouth, then we have practically one glass vessel, composed of two jars united at their mouths, the lower part containing carbonic acid gas and the upper oxygen, the two being in contact with one another. In spite of the fact that the lower gas is much heavier than the upper one, the two proceed to diffuse, the heavy one passing up into the light, and the light one passing down into the heavy. In course of time—and the time is not long—the vessel contains a perfect mixture of carbonic acid gas and oxygen. This is **diffusion of gases.** On pp. 193 and 194 it is stated that two liquids will mingle even when separated from one another by a membrane, and similarly two gases will mingle even when separated from one another by a membrane. Thus if a bladder be filled with oxygen, and if, after being firmly closed, it be placed in a jar containing carbonic acid gas, the oxygen will pass through the walls of the membrane to mingle with the carbonic acid, and the carbonic acid gas will pass inwards to mix with oxygen, until the bladder and the

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[1] This is shown in the following table, in which is stated the quantity of oxygen and of carbonic acid in 100 volumes of arterial blood, and 100 volumes of venous blood:—

	Oxygen.	Carbonic acid.
Arterial blood	20 volumes.	39 volumes.
Venous ,,	8 to 12 ,,	46 ,,

The quantity of nitrogen is the same in each, viz. 1 to 2 volumes.

jar contain equal mixtures of the two gases. Moreover, the process will be aided by the walls of the bladder being moistened with water. This is owing to the fact that liquids dissolve gases. Water exposed to an atmosphere of oxygen will lick up, or, to speak more correctly, will absorb some of the oxygen. It will do the same with other gases; and other liquids also absorb gases, though one liquid will absorb more of one gas than of another. Nay, one liquid, already containing a gas dissolved in it in quantity, is not thereby prevented from absorbing a quantity of another gas. So that, if the walls of the bladder be wet, one side is moistened with water containing oxygen in solution, and the other side is moistened with water containing carbonic acid gas in solution, and an interchange takes place between the two solutions, as described on pp. 193 and 194, so that oxygen passes outwards and carbonic acid gas passes inwards. Not only do liquids dissolve gases naturally, but they may be made by pressure to lick up much more than the usual quantity. As everyone knows, a bottle of aerated water contains water charged with carbonic acid gas. The gas is forced into the bottle by great pressure and the water compelled to dissolve it. The pressure is so great that, in order to compel the water to retain the gas, the bottle must be tightly corked and the cork bound down by wire. As soon as the cork is removed, the gas comes off with great force and produces the sparkling or effervescence of the water, while sometimes the pressure of gas in the water is so great as to blow out the cork or burst the bottle. Gas dissolved in a liquid exerts pressure on that liquid in its efforts to escape. If the pressure outside the liquid be less than that of the gas in the liquid, the gas will escape and come off; if the outside pressure be equal to that of the gas in the liquid, or greater, it will remain dissolved. Suppose, then, water containing oxygen in solution be placed in a jar filled with oxygen. If the pressure of gas in the jar be greater than that in the liquid, the water will take up more oxygen, but if it be less it will give off some oxygen, the result being that, in the end, the pressure of gas in the liquid and that outside of it become the same. In the same way if a liquid containing both oxygen and carbonic acid gas be exposed to an atmosphere of mixed oxygen and carbonic acid gas, unless the pressures of the two gases are the same in the liquid and in the atmosphere, an exchange will take place. If the pressure of oxygen in the liquid be less than the pressure of that gas in the atmosphere, oxygen will pass into the liquid till both are equal; and if the pressure of carbonic acid gas in the liquid be greater than that outside, carbonic acid gas will pass off from the liquid till both are equal, so that the liquid will gain oxygen and lose carbonic acid gas, while the atmosphere will lose oxygen and gain carbonic acid. The same process will take place even though the liquid be separated from the atmosphere by a membrane, and will occur more readily, as we have seen, if the membrane be moistened on both sides.

Now these facts explain to some extent the changes that occur in the blood in the lungs, for the conditions we have been speaking of are exactly fulfilled. Blood containing oxygen and carbonic acid gas is flowing in a multitude of tiny streams through the walls of the air-cells of the lungs. The air-cells contain a mixture of the same two gases. The blood is separated from the air in the air-cells by a thin membrane, namely, the delicate walls of the capillaries and of the air-cells, and the membrane is kept moist by the blood on the one side and the secretion of the membrane on the other. It has been found that the pressure of oxygen in the blood is less than that in the air-cells, and that the pressure of carbonic acid gas in the blood is greater than the pressure of the same gas in the air-cells. Consequently oxygen passes through the membrane from the air-cells into the blood, and carbonic acid gas passes through the membrane from the blood into the air-cells. The blood thus gains oxygen and loses carbonic acid, while the air-cells lose oxygen and gain the latter gas. At the same time the blood, by having its proper quantity of oxygen restored to it, and its excess of carbonic acid gas removed, changes in colour from purple to scarlet, from venous to arterial blood. It is re-invigorated and purified.

This much must further be noted, that the gases are not simply dissolved in the blood, but are partly in chemical union with it, and this affects to some extent, probably aids, the process.

It will readily occur to anyone that the result of this process will speedily be that the air-cells will be largely deprived of their oxygen and will contain chiefly carbonic acid gas. The pressure of oxygen will soon be even less in the air-cells than it is in the blood, and that of carbonic acid gas greater, so that the process would be reversed, oxygen taken from instead of added to the blood, and carbonic acid gas added to it instead of taken from it. This would make the blood more unfit than ever to nourish the body and more poisonous to it than before. It is evident that if the exchange is to continue of the proper character the air in the air-cells must be constantly renewed, its oxygen restored and its carbonic acid gas removed. How this is accomplished is the next question to consider.

Exchanges between the Outside Air and that of the Air-cells.—The air which we exhale during the act of expiration is very different in character from the external air which we inhale. Both contain principally the same three gases, though in different quantities, as the following table shows:—

	In 100 parts of	
	Air inspired.	Air expired.
Oxygen,....................	20·8	15·4
Nitrogen,..................	79·2	79·3
Carbonic Acid,............	·04	4·3

In other words, exhaled air contains roughly 5 per cent less oxygen and 5 per cent more carbonic acid than inspired air; the air taken into the lungs loses oxygen and gains carbonic acid. There are also other differences. Expired air is hotter because it has been in contact with the warm air-passages, and it contains more moisture than the external air also from contact with the moist lining membrane of the passages. This is readily observed by breathing on a cold surface, on which the moisture condenses. In expired air there is also a small quantity of animal matters, which gives to the air its stuffy smell.

The quantity of oxygen thus removed from the external air in 24 hours by the breathing of an adult person, as well as the quantities of carbonic acid gas and water given out in the same time, have been carefully estimated. About 18 cubic feet of oxygen are consumed daily by an adult man at rest. The same amount of carbonic acid gas is given out, and would be represented by a piece of pure charcoal weighing 9 ounces avoirdupois. The quantity of carbonic acid, however, varies according to circumstances, increasing up to the age of thirty and then diminishing, being increased also by external cold and by exercise, and being affected by the kind of food taken. The amount of water varies from 6 to 20 ounces daily, on an average it is about half a pint.

The explanation of the difference in the composition of the air inhaled and the air exhaled is simple. During the pause that follows an act of expiration the lungs, that is the bronchial tubes and air-cells of the lungs, are still filled with air. That air, particularly in the air-cells, must be different from fresh air, because the blood is continually drawing oxygen from it and adding carbonic acid to it. When an inspiration occurs the lungs distend, and 30 cubic inches of fresh air enter to fill up the increased space. The new supply occupies only the upper air-passages. An expiration immediately follows the inspiration, but the 30 cubic inches that have previously entered are not expelled. A like quantity is exhaled, but it contains only about one-third of the 30 cubic inches just inhaled. For the supply of fresh air has no sooner entered the lungs than it proceeds to mingle with the air already there, to diffuse into it, and two-thirds of it have already passed down a considerable way towards the air-cells before the expiration which follows its entrance occurs. By the process of diffusion the fresh supply passes downwards towards the air-cells, increasing the quantity of oxygen already in the air in the lungs and diluting the carbonic acid. Of the air given out of the lungs in a breath, while one-third is formed of air that has entered just previously to the expiration, the remainder is air from the lungs charged with carbonic acid and deficient in oxygen, which has been displaced by the fresh air. The purpose of breathing is thus apparent: it is to restore to the air in the air-cells of the lungs the quantity of oxygen of which it is being regularly deprived by the blood, and to rid it of the excess of carbonic acid imparted to it by the blood. The two processes that have been now described must keep pace with one another: the process by which the blood takes oxygen from the air in the air-cells, and gives to it carbonic acid, must be counterbalanced by the process by which a certain quantity of fresh air is drawn into the lungs to restore the lost oxygen, and a certain quantity of air is expelled from the lungs to remove the excess of the hurtful gas.

A survey of the ground that has been gone over reveals how the structure of the lungs, the arrangement of the blood-vessels in the walls of the air-cells, and the action of the distention and recoil of the chest and lungs are all adapted to work together for this one end, namely, to facilitate exchanges of gases between the blood and the air.

VENTILATION.

(For a fuller discussion of this subject refer to p. 246, Vol. II.)

It has been said that if no provision existed for regularly renewing the air in the air-cells, it would become so deficient in oxygen, and so charged with carbonic acid gas, that the proper exchanges could not take place between it and the blood, which, instead of being purified, would become more impure. That remark has a wider application. By the process of breathing we remove oxygen from the atmosphere and add to it carbonic acid, so that if the external air is to remain fit for respiratory purposes it must, like the air in the air-cells, be continually renewed. Ventilation is the term applied to the means by which the due renewal of the external air is accomplished in inclosed spaces. Suppose a man were to be shut up for a long time in a confined space into which no fresh air could enter, by and by the air in the space would approach more and more to the character of the air in his lungs, the purification of the blood would cease, and continued life would be impossible. Long before this, however, the impurity of the atmosphere would be revealed, by headache, languor, and oppression. The presence of from 1½ to 3 parts of carbonic acid in every 1000 of our atmosphere is liable to produce headache and giddiness in those breathing it. The problem of ventilation is to remove bad air and supply fresh without causing draughts. In order that sufficient pure air may be present in rooms, &c., in which persons are living, it has been estimated that for each individual there should be a space of, on an average, 1000 cubic feet, and that 3000 cubic feet of pure air per head per hour should be supplied to maintain a proper standard of purity of air in the apartment. It is the excess of carbonic acid whose effects have been chiefly noted. Deficiency of oxygen also causes marked effects, producing difficulty of breathing (dyspnœa) and suffocation (asphyxia), the prominent feature of which is convulsions. These effects are considered under their respective headings in the section which follows.

It is curious that a tolerance for impure air can be established within limits. That is to say, a person may become accustomed to breathe, without any signs of inconvenience, a very impure air, which another, coming directly from the fresh air, could not tolerate for a moment.

ARTIFICIAL RESPIRATION.

(Refer to p. 580, Vol. II., and Plates LX. to LXIV.)

We have seen that the entrance of air into the lungs is the direct result of the expansion of the chest. If, therefore, the chest can be expanded artificially, air will enter and breathing may be maintained. This can be done even on the dead body. The various methods that may be adopted for restoring suspended breathing are described in Vol. II.

ALTERED RESPIRATORY MOVEMENTS.

Coughing is produced by some irritation specially in the upper part of the windpipe and the larynx. As a result a deep breath is drawn, the opening of the windpipe is closed, and then suddenly burst open by one or several rushes of air, which pass out by the mouth. The object of this is to dislodge and carry away in the rush the material that is the cause of the irritation.

Sneezing is caused by an irritation of the nostrils or eyes, producing results similar to those in coughing, the air, however, escaping by the nostrils. In the beginning of a cold in the head it is the cold air irritating the inflamed lining membrane of the nose that causes the repeated attacks of sneezing. In some forms of inflammation of the eyes the stimulus of light produces sneezing. The eyes are usually kept shut by the sufferer, and the attempt to open them ends frequently in a sneeze.

Sighing consists of a prolonged and slow inspiration, followed by a similar expiration.

Yawning is a very deep inspiration, and is accompanied by movements of the lower jaw, so that the mouth is widely open.

In **hiccough** (p. 233) there is a sudden inspiration, abruptly checked by the closing of the opening of the windpipe (the *glottis*). The sound that it produces is due to the entering air striking against the closed glottis. It is occasioned by irritation of branches of the pneumo-gastric nerve ending in the stomach.

Laughing consists of a series of short spasmodic expirations, succeeding a long breath, the vocal cords, whose movements produce voice, being thrown into activity. It is accompanied by characteristic movements of the face.

Crying is similar, and is associated with different movements of the face.

In **sobbing** there is a series of short convulsive inspirations.

VOICE.

THE ORGAN OF VOICE.

The Voice-box or **larynx** forms the upper part of the windpipe. It is constructed of various curiously-shaped pieces of cartilage (gristle), connected together by bands of ligament, and is clothed outside by muscles, and inside by a mucous membrane continuous with that of the rest of the air-passages. Fig. 154 shows the larynx and windpipe stripped of muscles. The larynx (L) is seen to be formed of two pieces of cartilage (*Th* and *Cr*), one placed above the other. The upper of the two is the **thyroid** cartilage, and the lower the **cricoid** cartilage.

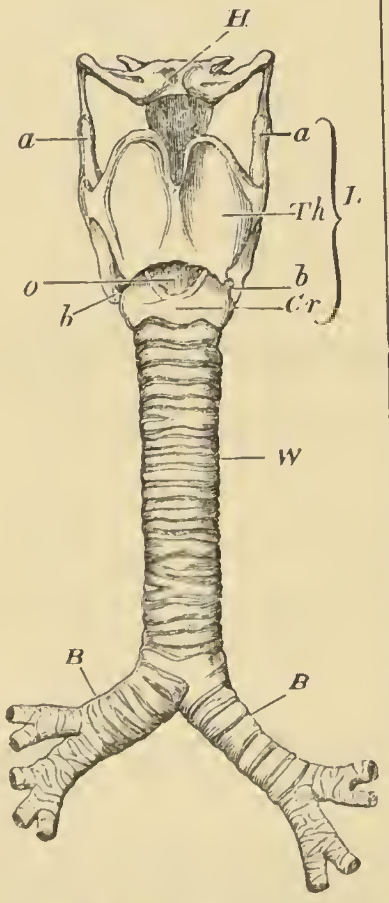

Fig. 154.—The Larynx (L); Windpipe (W); and Bronchial Tubes (B B); e, Epiglottis.

The thyroid cartilage (Greek, *thyreos*, a shield) is formed of two extended wings meeting at the middle line in front in a ridge; above and from the sides two horns project upwards (*a*, *a*), which are connected by bands to the hyoid bone (H), from which the larynx is suspended. The hyoid bone itself is attached by muscle and ligament to the skull. It lies at the root of the tongue, and the finger can feel it at the angle of junction of the chin and neck. From the under surface of the thyroid two horns (*b*, *b*) project downwards to become jointed to the cricoid. The thyroid cartilage thus rests and is movable on the cricoid, movable forwards or backwards, but not from side to side.

The cricoid cartilage is shaped like a signet-ring (Greek, *krikos*, a ring), the narrow part of the ring being in front. Owing to this narrowness a small space (*o*) is left in front between the two cartilages. The space is closed by membrane. It is through this space that an opening is often made in cases of threatened suffocation owing to some obstruction higher up. The operation is known as **laryngotomy** (cutting the larynx), and is to be distinguished from **tracheotomy**, in which the windpipe is opened.

The appearance of the larynx is very different when viewed from behind, as in Fig. 155. The thyroid cartilage is not complete behind, while the cricoid is broader than in front. The cricoid carries, perched on its upper edge behind, two other cartilages, of great importance in the production of the voice.

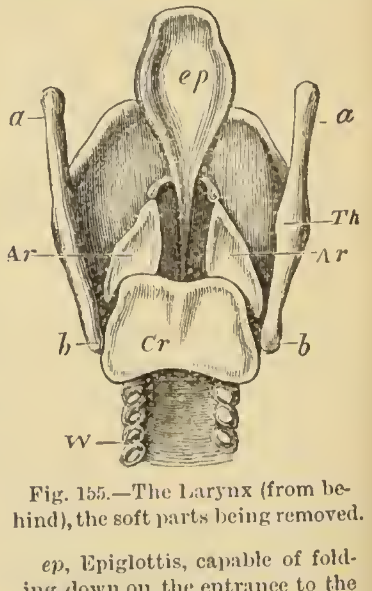

Fig. 155.—The Larynx (from behind), the soft parts being removed.

ep, Epiglottis, capable of folding down on the entrance to the larynx like a lid and so closing it. See p. 342. The letters not mentioned in the text apply to the same parts as those of Fig. 149.

The arytenoid cartilages (*Ar*, Fig. 155) are triangular in form, as shown in the figure. On their summits are perched small pieces of cartilage, and, when in their natural position, the two form a shape resembling the lip of a ewer, hence their name (Greek, *arutaina*, a pitcher).

Now these various cartilages form a framework on which muscles and mucous membrane are disposed. Thus, towards the front, one muscle passes from the cricoid up to the thyroid on each side, and when the muscle on each side contracts, the thyroid cartilage is pulled downwards and forwards on the pivot its lower horns form with the cricoid. Another muscle passes from each arytenoid cartilage behind to the thyroid cartilage, and when it contracts it pulls up the thyroid to its original position. Other muscles will be noted immediately.

The Vocal Cords.—The mucous membrane, which lines the inside of the box formed of the cartilages described, is thrown into various folds. In particular one fold passes horizontally outwards from each side towards the middle line at the level of the base of the arytenoid cartilages. The free edge of each fold is formed by a band of elastic fibres that passes from each arytenoid cartilage straight forwards to become attached to the thyroid cartilage. These folds are called the **true vocal cords**, by whose movements voice is produced. They are called *true* vocal cords because above them are folds of mucous membrane called the *false* vocal cords, which take no part in the production of voice. The true vocal cords, projecting towards the middle line, encroach upon the space, and reduce the communication between the part of the larynx above them and the part below to a mere chink. This chink is called the **glottis** (from Greek, *glotta*, the tongue) or the **chink of the glottis**. Fig. 156 will perhaps render this more easily understood. It represents the larynx, &c., viewed from behind, with all the soft parts in connection with it. On looking down, the folds forming the true cords (*c*) are seen, inclosing a V-shaped aperture, the glottis, the narrow part of the space being towards the front. Now by the contraction of various muscles the form of the aperture may be changed. The vocal cords may be brought so closely together that the space becomes a mere slit. Air forced through the slit will throw the edges of the folds into vibration, and a sound will be produced. Variations in the form of the opening will determine variations in the sound. This, briefly, is the mechanism of the production of voice. If all the muscles of the larynx be relaxed the folds do not project nearly so far towards the middle line, the aperture of the glottis is wide, and air may enter and leave the windpipe during the acts of breathing without throwing the cords into vibration so as to produce any sound.

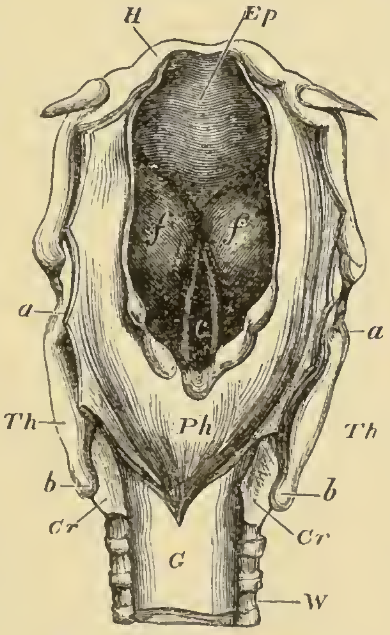

Fig. 156.—View of Larynx from behind with all the soft parts.

f, false cords; *c*, placed in chink of the glottis, is between the two vocal cords; Ph, pharynx; G, gullet. The other letters are the same as in Figs. 154 and 155.

THE PRODUCTION OF VOICE.

Voice is then produced by arrangements precisely similar to those of some musical instruments. The organ of voice is, indeed, a reed-instrument, the sound produced by the vibrations of the reed or vocal cords being modified by the tubes above and below.

Musical sounds are due to movements or vibrations occurring with a certain regularity, and they differ in loudness, in pitch, and in quality.

Loudness of the sound depends on the extent of the vibrations.

Pitch of the sound depends on the rapidity of the vibrations.

Quality of the sound depends on the admixture of tones produced by vibrations of varying rates of rapidity related to one another. A tuning-fork vibrating 100 times per second gives out what is called a pure tone. If several other tuning-forks, vibrating at rates which are multiples of 100, say 200, 300, 400, &c., be thrown into vibration, the sounds emitted by them will blend with the sound of the first or fundamental tone, and the quality of the sound will be changed though its pitch remains the same. The tones that have been added are called **overtones**. The quality of a musical sound, therefore, depends on the overtones in it. Thus if the same note be produced on a piano, a violin, and a trumpet, the quality of the note of each will be markedly different, though the three notes are of the same pitch, the difference being due to the different overtones present in each. Human voices uttering the same note differ in quality, because the construction of the vocal apparatus of one individual favours the production of a different set of overtones from those of another.

In the production of the voice, then, there are to be noted the arrangements for (1) the vibration of the cords to produce sound, (2) the regulation of the loudness of the sound, (3) the variation of the pitch of the sound, and (4) the determination of the quality of the sound.

The Vibration of the Vocal Cords.—In order that the cords may be thrown into proper vibration they must be brought close together and parallel to one another, so that only a narrow slit intervenes between them, through which air is driven with some degree of force. The vocal cords are brought together, so that the space between them is narrowed to a slit, by the action of a muscle which passes from the cricoid cartilage to the outer angle of the arytenoid cartilages. When the muscle of each side contracts, the arytenoid cartilages are caused to turn on their bases, so that the vocal cords attached to them are brought close up to one another. Other muscles assist in the manœuvre. This having been accomplished, a strong expiration drives the air from the lungs through the slit between the cords, and throws them into movement. Other muscles are connected with the arytenoid cartilages which cause them to rotate in an opposite direction, so separating the vocal cords and widely opening the glottis.

By means of an arrangement of mirrors, called the **laryngoscope**, devised in modern times, this operation can be easily seen. A person is seated upright in a chair, a lamp, throwing a strong light, being placed on a table at his side and slightly behind him. In front of him an observer sits, who has a slightly concave mirror fixed on his forehead. The person opens his mouth, and the observer arranges the mirror so as to catch the light from the lamp and reflect it in a bright beam into the person's throat. The observer then takes a small plane mirror, not so large as a shilling, set at an angle on a long stem, and, having slightly warmed it, passes it to the back of the person's throat, the person's tongue being pulled gently forwards meanwhile. The observer so places the plane mirror that the light from the mirror on his forehead is thrown on to it, and is then reflected downwards to illuminate the larynx. It requires, of course, some practice and dexterity to arrange the mirrors properly. When it is skilfully done, the observer is able to see in the plane mirror a view of the illuminated larynx, with its lining membrane and vocal cords. When the person is breathing quietly, the chink of the glottis is seen widely open, but as soon as he utters a sound, as that of *a* in *far*, the cords are seen to advance quickly towards the middle line, so that the passage is completely closed but for the narrow slit between them. A good view of the cords is thus obtained, and they should be pearly white and glistening, with clean-cut edges. The vibration is little in amount, but very rapid.

The amount of vibration.—The extent of movement of the cords will vary with the force of the outgoing current of air, and thus the loudness of the sound will increase with greater force of expiration.

The rapidity of the vibrations.—The pitch of sound depends, as we have seen, on the rapidity of the vibrations, and that is determined by two circumstances—the length of the cords and their tightness, for the shorter and tighter a string is the higher the note which its vibration produces. The vocal cords of women are about one-third shorter than those of men, hence the higher pitch of the notes they produce. The cords of tenor singers are also shorter than those of basses and baritones. In children the vocal cords are shorter than in adults. In boys, at the period of puberty, the larynx enlarges. This is accompanied by an elongation of the cords, and a consequent change in the pitch of the voice, which becomes lowered. In popular language the voice is said to *crack*. Thus age and physical growth determine the pitch of the voice. Voluntary variations in pitch are due to the fact that the tension or tightness of the cords can be varied at will by muscular movements. It has been pointed out (p. 354) that the thyroid cartilage can be pulled downwards and forwards over the cricoid by the action of the crico-thyroid muscle. Now the front ends of the vocal cords are attached to the inner surface of the thyroid, and when it is pulled forwards they are stretched, provided the arytenoid cartilages to which their other ends are connected are fixed. The more strongly the thyroid cartilage is pulled on, the higher will be the pitch of the note produced by the vibration of the cords, because the greater will be their degree of tightness. It is believed by some, also, that the vocal cords may be shortened by muscular action causing the cords to overlap one another, so that part of their length is "stopped", and so prevented vibrating. This would also increase pitch, just as a violinist varies the pitch of a note produced by his violin string by "stopping" it at varying distances. It has been suggested that it is such a "stopping" action that determines the production of the falsetto voice.

In opposition to muscles whose contraction tightens the cords are others which pull up the thyroid cartilage, and otherwise produce relaxation and shortening of the cords, and consequently lowering of the pitch of the voice.

The quality of the voice depends on physical conditions of the cords, their degree of smoothness, elasticity, thickness, &c. Moreover, the form of the windpipe, larynx, throat, mouth, &c., takes part in determining quality. In fact, the air-passages both below and above the vibrating cords act as resonators, or resounding chambers, and intensify and alter the sounds produced by the cords. Indeed, the sounds emitted by the cords would be feeble but for the intensifying action of the air-passages. By their form, however, they are fitted to intensify some notes more than others.

The quality of an individual's voice is as much determined, therefore, by the shape and general structure of his throat, mouth, &c., as by his vocal cords. It may be remarked that a knowledge of this fact shows the necessity of the mouth being properly opened during speech, and especially during singing. Each person has the power to alter the shape of his mouth, and so is able to adapt it to a great extent to intensify any particular sound he wishes to utter.

In the ordinary production of voice, therefore, there is a great variety of muscular movement of a very delicate character; how complicated and rapid must be the movements executed by a singer! It is impossible to conceive the delicacy and complexity of the movements voluntarily executed by the well-trained and skilful singer, who adapts vocal cords, larynx, throat, mouth, &c., with speed and precision, so as to produce accurately the desired sounds. The muscular movements involved are all produced in response to nervous stimuli reaching the muscles from the brain.

Various points worthy of notice in connection with the care of the voice will be considered in the succeeding section.

Voice is, then, produced in the larynx, and is altered by the rest of the respiratory passages.

SPEECH.

Speech is to be distinguished from voice. It may exist without voice. A whisper is speech without voice. Speech is due to sounds produced by the action of the throat, mouth, and nose. In ordinary talking it is accompanied by vocal sounds. In speech, then, are vowel and consonantal sounds.

Vowel sounds are sounds produced in the larynx, whose quality is markedly altered by the shape of the resounding chambers above, especially the mouth. Thus, let a person sound a particular note, and utter the vowel sound, *a* (as in *father*), *e* (as *a* in *fate*), *i* (as *ee* in *feet*), *o* (as in *cold*), and *u* (as *oo* in *foot*), and he will find that continuing to sound a note of the same pitch he can produce all the vowel sounds, by alterations in the shape of the mouth principally.

Consonants are sounds produced by interruptions of the outgoing current of air, but in some cases are preceded or followed by vocal sounds. The interruption to the outgoing current may take place by movements of the lips, as in pronouncing *p*, *b*, *f*, *v*. These are **labial** consonants (Latin, *labium*, a lip). *M* is also a labial consonant, in which there is a vocal sound suddenly interrupted by a lip movement.

When the tongue, in relation with the teeth or hard palate, obstructs the air, **dental** consonants are produced, *d*, *t*, *l*, *s*. *N* is a dental consonant, a vocal sound being suddenly checked by the tongue and teeth. *S* is also a dental sound, caused by the teeth offering an obstruction to a continuous rush of air past them.

Gutturals are due to the movements of the root of the tongue in connection with the soft palate or pharynx, such as *k*, *g*, *ch*, *gh*, *r*.

In the production of *ng*, a vowel sound is interrupted by the approach of the root of the tongue to the soft palate. It is thus a guttural sound.

SECTION XVII.

THE AIR-TUBES AND LUNGS (THE RESPIRATORY SYSTEM).

ITS DISEASES AND INJURIES.

The Examination of the Chest:
- *Inspection; Auscultation; Percussion*—The Stethoscope.
- *Roentgen-ray Examination of the Chest;*
- *Microscopical Examination of the Spit.*

Diseases of the Lining Membrane of the Lungs (*Pleura*):
- *Inflammation of the Lining Membrane*—(*Pleurisy*)—Dropsy—Empyæma—Pneumothorax.

Diseases of the Larynx, Windpipe, and Bronchial Tubes:
- *Inflammation of the Larynx* (*Laryngitis*)—Tracheotomy;
- *Dropsy of the Larynx* (*Œdema*)—Scalding of the larynx;
- *Inflammation of the Windpipe* (*Tracheitis*)—Croup;
- *Inflammation of Bronchial Tubes* (*Bronchitis*)—Chronic Bronchitis;
- *Ulceration of Air-Passages;*
- *Dilatation of Air-Passages* (*Bronchiectasis*);
- *Spasm of the Larynx and Bronchial Tubes*—Asthma—Hay-Asthma;
- *Tumours and Foreign Bodies in the Air-Passages.*

Diseases of the Lungs:
- *Inflammation* (*Pneumonia*)—Chronic Pneumonia (*Cirrhosis*);
- *Congestion*—Dropsy—Gangrene and Apoplexy;
- *Spitting of Blood* (*Hæmoptysis*);
- *Dilatation of Air-Cells* (*Emphysema*);
- *Collapse* (*Atelectasis*);
- *Tumours and Cancer; Injury of the Lungs.*

Consumption or Tubercular Disease of the Lung (*Phthisis—Decline*):
- *The Infective Nature of Consumption—the Tubercular Organism;*
- *Individual Susceptibility and its Variation by Age, Occupation, Habits, Surroundings, and Hereditary Influence;*
- *The Site of Attack; Changes in the Lungs;*
- *The Tubercular Poison and Infection of other Organs;*
- *Types of Consumption: Acute Tuberculosis—Galloping Consumption—Chronic Consumption—Fibroid Phthisis.*

The General Treatment of Consumption:
- *General Rules—Special Treatment of Cough, Sweating, Diarrhœa, Pain, Bleeding;*
- *The Drug Treatment of Consumption;*
- *Sanatorium Treatment; Prevention of Consumption.*

Special Symptoms connected with Affections of the Lungs:
- *Cough;*
- *Difficulty of Breathing* (*Dyspnœa*) and *Suffocation* (*Asphyxia*)—*Apnœa*;
- *Lividity* (*Cyanosis*).

Affections of Voice and Speech:
- *Hoarseness; Clergyman's Sore Throat;*
- *Loss of Voice* (*Aphonia*); *The Care of the Voice;*
- *Stammering or Stuttering;*
- *Inhalation of Irritating and Poisonous Gases.*

THE EXAMINATION OF THE CHEST.

There are few organs of the body whose condition can be so directly observed by a physician as the lungs, few in the examination of which the physician is so independent of the feelings of the patient. This is due to the adoption, in quite modern times, of methods of investigation by means of which a physician can, in very many cases, ascertain for himself the condition of a person's lungs without asking him a question. It may be well to note briefly how such an examination is made.

Inspection.—Much information may be gained by simply viewing the chest in a good light, the person sitting upright. Its shape is regarded first of all. In children the shape is circular, in grown-up people the distance from side to side is greater than from front to back. In disease the shape may be altered in various ways: it may bulge at one side, or be drawn in at one side. The "pigeon chest" shows a marked change in shape, the breast-bone being thrust forwards, and the sides flattened. It is the result of such disease as whooping-cough, occurring in childhood, when the bones are soft and readily yield to strain. In rickety children the shape is also greatly altered.

Again, by the simplest inspection one may frequently detect flattening in some part. This occurs specially just under the collar-bone, and indicates that, under that place, the lung does not sufficiently expand. Inspecting the chest in this way gives information also about the movements of breathing. Movement increased in one place and lessened in another indicates something unusual. In children particularly an impediment to the free entrance of air into the air-cells is shown by a heaving motion of the belly, accompanied by a sucking in of the lower ribs.

Auscultation is another method. It has been mentioned that the ear applied closely to the chest walls hears sounds of the expanding lungs—a fine rustling noise. If part of a lung be blocked up, no sound will be heard over it. If matter be present in the bronchial tubes, as in bronchitis, the air, as it enters and leaves the lungs, will bubble through it, and give rise to bubbling or gurgling or crackling sounds; or if the tubes be narrowed by inflammation or spasm, whistling or piping sounds will be heard as the air rushes through the narrowed passages. Auscultation may be performed, as stated, by applying the ear directly to the chest, only a soft handkerchief being interposed between ear and skin. It is also performed by means of the **stethoscope**, a tube made of wood, or vulcanite, or metal, having a widened portion at one end for placing on the chest, and a larger expanded part at the other for fitting the ear. The sounds are conducted to the ear by this means. It may be observed that an untrained ear will very readily fail to catch the soft breath sounds of healthy lungs, which the accustomed ear can perceive at once, so that anyone unused to listening over the chest should not conclude that the breath sounds are abolished because he cannot hear them. They are particularly loud in children.

Percussion is a third method of examining the lungs, a method already alluded to as used to determine the extent of the liver and heart (pp. 271 and 319). Everyone knows the hollow sound given out on tapping a cavity filled with air, and the dull, dead sound given out on tapping a solid board. The lungs, consisting of numerous minute cavities filled with air, ought to give out a clear hollow sound when the chest is tapped; but if the air-cells of a lung, or part of it, are blocked up with inflammatory material, if, that is to say, that part has become practically solid, or if a large quantity of fluid has collected in the sac of the lung—the pleural cavity (p. 344)—the dull sound will be produced on tapping the chest over that part. The tapping may be done by the knuckles or tips of the fingers. The best way is to lay a finger of one hand flat on the chest and tap smartly on it with the point of a finger of the other hand. The sounds are thus easily brought out, and the whole surface of the chest may be gone over in this way to see if all parts are equally clear and *resonant*, as it is called. Of course when one taps over the heart the dull sound is produced. The diagram (Fig. 133, p. 297) shows where dulness ought to be usually found, and what extent of the chest ought to yield the clear note of the lungs.

There are various alterations of the sounds, heard on auscultation and percussion, produced by disease, which it does not fall within the scope of this work to comment on.

Roentgen-ray Examination of the chest is a quite recently added method of medicine. By its means and also by Roentgen-ray photography changes may be detected in the lungs, not easily detected by other means. This is illustrated in Plate XVIII.

Microscopical Examination of the Spit is another method of determining the true nature of some chest disease. A small portion of spit is spread on a glass slide in a very fine film, is dried, heated, stained, and mounted, exactly as has been described in the case of blood films (p. 18). This film is then examined by a high-power microscope for the organism of consumption—the tubercle bacillus, or for the organism of pneumonia. Plate XXI. shows the appearance of spit, when so treated, from a case of consumption.

Besides signs of disease of the lungs, thus obtained, there fall, of course, to be added symptoms, ascertained by inquiry of the patient, such as the presence or absence of pain, cough, spit, difficulty of breathing, &c. &c.

DISEASES OF THE LINING MEMBRANE OF THE LUNGS—THE PLEURA.

PLEURISY AND DROPSY OF THE CHEST.

Pleurisy (*Pleuritis*) is the name given to inflammation of the serous membrane that incloses each lung as by a sac. The membrane, as described on p. 344, is formed of a double layer, one fold being closely applied over the lung, and the other over the chest wall, a slight space, in which a small quantity of serous fluid is usually present, being between the two. Now inflammation affecting this membrane is of the same nature as inflammation occurring anywhere else, and its features have been stated on p. 327. The blood-vessels of the membrane, for it is richly supplied with them, are congested, and materials pass out of them into the sur rounding tissues, so that the membrane becomes thickened. A considerable quantity of material is poured out on the surfaces of the pleura, and separates into a fibrinous or coagulable portion and a fluid—serous—part. The fibrinous material is deposited on the surface, and the fluid escapes into the small space between the two folds of the membrane. The surfaces of the folds, which are opposed to one another and ought to glide smoothly on one another with the movements of breathing, are roughened in consequence of the deposit. The movement, instead of being smooth and noiseless, is accompanied by considerable friction, which occasions a fine rubbing sound that a practised ear can detect by listening with the ear to the chest. If a large quantity of fluid is poured into the space, it will separate the two layers of the pleura, and the friction, with its accompanying sound, will cease. Whether much or little fluid accumulates in the pleural sac depends on the nature of the case. In some instances only a few ounces are present, in others the quantity is many pints. So much fluid must make accommodation for itself between the lung and the wall of the chest. It may make some room by forcing out the wall of the chest and making the chest perceptibly fuller on the affected side. But the ribs do not yield very much or readily, and the fluid will make more space by displacing the organs of the chest and crushing the lung together as much as possible. For example, if the pleurisy be on the left side, the heart may be pushed over to the right side by the accumulating serum. The pressure of the fluid on the lung may be sufficient to expel the air from its air-cells, and compress the substance of the lung so that it is squeezed into a compact mass, and the air-cells no longer exist. In some severe cases of this kind the pressure on the lung has been so great that, after death, on the affected side only a small fleshy mass, pushed up into a corner of the chest, remained as evidence of the existence of a lung, the cavity being completely occupied by fluid. **Dropsy of the chest**, or **hydrothorax** (Greek, *hudor*, water, and *thorax*, the chest), is the term applied when the accumulation of fluid is considerable. Of course, in the chest the fluid will seek the lowest level, and thus, at first, it will occupy the bottom of the cavity, surrounding the lung, compressing to some extent the extreme parts of the lung; but, as it increases in amount, it will rise, squeezing the air out of the lung as it ascends.

In the ordinary run of cases so much fluid is not poured out as to cause complete collapse of the lung. The inflammation passes away. Processes of repair set in. The poured-out fluid begins to be absorbed, partly by blood-vessels, partly by lymphatics (p. 278), and, as it diminishes, the lung, released from the pressure, slowly expands. In time the fluid is all removed, the two folds of membrane glide on one another again, and, their surfaces being rough, friction is reproduced. Generally also the roughened surfaces become adherent to one another, either in parts or throughout their whole extent, and the pleural cavity ceases to exist. This is practically complete recovery. The case, however, may not end so favourably as this. The lung may have been so much compressed that when the fluid is removed it cannot expand, or can only expand to a slight extent. There being nothing to fill the space it should occupy, the wall of the chest is sucked in, the organs in the chest are pulled over to that side, and the person acquires a peculiar way of holding himself, his shoulder dropping, and his whole body leaning to the affected side. In another way the end may be unfortunate. Matter may be formed in the cavity of the pleura, and an abscess result, which may in time discharge itself into the lung, the matter being spat up, or may point and open to the outside, an open channel leading from the outside to the cavity. This condition is called **empyæma** (Greek, *en*, within, and *puon*, matter).

The common **cause** of pleurisy is exposure to cold. It may be caused by injury—a broken rib, for example, pushed inwards and damaging the membrane. It is sometimes a complication of fevers—scarlet fever, typhoid fever, &c.—of kidney disease, of heart disease, and of blood-poisoning; and it is frequently tubercular. It may also be due to disease of the lungs themselves, that part of the pleura being involved that lies over the diseased area of lung. A small part only of the pleura may be affected in this way, and no pouring out of fluid occur, but the two folds of membrane become adherent at the irritated part. This is called **dry pleurisy**.

Symptoms.—Usually the first thing of which a person affected with pleurisy complains is a pain or stitch in the side. The pain is of a stabbing or tearing character at a particular place, and does not move about. It is increased by deep breaths, generally becomes intense with coughing, sneezing, &c., and is increased also by moving the arm of that side. Loss of appetite, weakness, feverishness, furred tongue, quick full pulse, short shallow breathing, scanty and high-coloured urine are among the other symptoms. A short, dry cough is also common. The fever does not run very high, 102° or 103°. The conclusive signs are obtained by examining the chest. In the early stage, before fluid has been poured out, the friction sound referred to above may be heard. When effusion has taken place in any quantity, tapping the chest gives out a dull sound, and the breath sounds can no longer be heard (see p. 359). By tapping, the level of the fluid can be ascertained, the person sitting up, for as soon as one taps higher than the level of the fluid, a clear sound is produced. Another method, that even the most unpractised can make use of, is to apply one hand close to each side of the patient, the chest being quite bare, and then to ask the person to speak. The thrill of the voice ought to be communicated equally to each hand. If the pleura on one side is full of fluid, the thrill will be absent on that side. If the lung on one side has become solid, owing to inflammation or other cause, the pleura containing no fluid, the solid lung will conduct the sound even more easily than the lung filled with air, so that while the thrill is felt on both sides, it will be very much increased on the diseased side. When fluid has been poured out, the pain usually begins to subside. In the early stage of the illness the person lies commonly on the sound side, pain preventing him turning on to the other. When much fluid has been poured out, however, he lies on the affected side, for if he were to lie on the sound side, the weight of the fluid on the top side would too much embarrass breathing. With effusion difficulty of breathing is greatly increased, and the person may even become livid, and breathes rapidly. Commencing recovery is indicated by diminished pain and feverishness. But the effusion remains long after the inflammation has passed, as is indicated by the breathlessness on sitting up, or on the slightest exertion. A physician determines the progress towards complete recovery by tapping to discover whether a clearer sound is produced, and by listening to discover the return of the breath sounds.

In some cases the onset of the disease is not well marked, the patient suffering from languor and weakness, with stitch in the side, other symptoms being slight. Perhaps it slowly passes off, without the person being aware that he was affected with a serious disease; perhaps his symptoms increase till he is forced to lay himself up. In other cases the attack is sudden and severe, shivering fits, with high fever and severe stitch, indicating its occurrence.

Among the symptoms of formation of matter are shivering fits followed by sweatings.

Treatment.—The person should from the outset have perfect rest in bed, little talking being allowed, a good dose of opening medicine (epsom or seidlitz salts) being given early, and light nourishing diet being administered without stimulants. Large hot linseed-meal poultices should be frequently applied to the affected side, to which mustard may be added now and again. A large flannel bandage round the chest should secure the poultices, and a dry one should be applied when the poultices are off. If the pain is severe ½ grain of opium, or 12 drops of laudanum, may be given (to adults only) twice or thrice daily. That will, however, bind the bowels, which should be relieved by additional medicine, or by injections. When recovery has begun, moderate nourishing diet is to be given, and quinine and iron tonic, or iodide of iron (a tea-spoonful of the syrup four times daily). To aid the absorption of the fluid, occasional mustard poultices may be applied to the side, or fly-blisters may be used on one part of the side one day, and a day or two after on another part. Rubbing the side is useful if the condition of the skin permits. An occasional dose of medicine is a help.

It must be remembered that, even in favourable cases, the absorption of the fluid poured out takes some time—weeks, and even months. Further, freedom from breathlessness is no sign of absence of fluid, for there may be a considerable accumulation of fluid and little breathlessness. For months after the attack great care must, therefore, be exercised.

Where the collection of fluid is very great, or where matter has formed, physicians now employ methods for the withdrawal of the fluid by inserting a fine tube into the pleural space through the chest wall, between two ribs, usually the 5th and 6th or 6th and 7th, about the line of the arm-pit. It is done with precautions to prevent the entrance of air and various impurities.

Pneumothorax is the term applied when there is an accumulation of air in the cavity of the pleura. The air may gain entrance from the outside by a wound, or from the lung by an opening produced by an abscess. It produces difficulty of breathing. If an opening communicates from the outside with the cavity, the lung on that side will not expand with the movements of inspiration, because it is easier for the air to enter by the opening to occupy the enlarged space than for it to enter the lungs and overcome their resistance to expansion.

DISEASES OF THE LARYNX, WINDPIPE, AND BRONCHIAL TUBES.

INFLAMMATION.

A description of catarrh, or "cold in the head," is given on p. 214, and it has there been pointed out how this condition, beginning in the nose, may extend to the throat and on to the windpipe and bronchial tubes, developing, that is to say, into "cold in the chest." In nasal catarrh the mucous membrane lining the nostrils becomes red and swollen, is easily irritated—even cold air irritating it and causing sneezing,—and in a short time pours out a discharge, at first watery and then thick. Now the mucous membrane of the throat is continuous with that of the nostrils, so also is that of the larynx, so also is that of the windpipe. The bronchial tubes, down even to their finest branches and their ultimate endings, are lined with a mucous membrane continuous with that of the windpipe, larynx, and throat, and through them with that of the nose. The inflamed or catarrhal condition of the nostrils may thus extend, through mere continuity of the membrane which it affects, right down the windpipe and bronchial tubes. Moreover, any part of this continuous membrane may be separately affected by a catarrhal condition. But in whatever part of the mucous membrane the catarrh appears, it exhibits essentially the same characters, any differences that may be observed being due, not to any change in the nature of the inflammation, but simply to the position which it occupies. Thus inflammation of the larynx, inflammation of the windpipe, and inflammation of the bronchial tubes are simply forms of catarrh in different situations.

Inflammation of the Larynx (*Laryngitis*).—Here the changes already alluded to affect the mucous membrane of the larynx. The membrane becomes red, swollen, and at first dry; later, the membrane secretes fluid which soon becomes thick and glairy, and contains pus. The inflammation passes off gradually, by the membrane becoming less engorged with blood, and less swollen, but a relaxed condition is apt to remain for some time.

The **causes** of the disease are usually exposure to wet or cold. The inflammation may also be due to the direct action on the membrane of some irritation. For example, the fumes emitted from some forms of galvanic cells—Bunsen's or Grove's cell, for instance—are extremely irritating to the throat, and if one incautiously works in the room where a battery of such cells is, inhaling the fumes is apt to provoke an attack of laryngitis. In some diseases of the lung the matters that are brought up are irritating to the larynx and windpipe. Violent exertion in speaking or shouting may also be a cause. In various other diseases, small-pox, measles, scarlet fever, kidney disease, this affection may be a complication. Thus it is not uncommon to find children developing suddenly the signs of laryngitis, the hoarse barking cough, altered voice, &c., with fever, that make the parents believe croup to be coming on, and next day the cause is revealed by an abundant crop of the eruption of measles. The poison in the blood, that is to say, has inflamed the mucous membrane of the larynx as it has inflamed that of the eyes and nose, as the streaming eyes and sneezing testify.

Symptoms.—That the affection is the result of a cold is frequently evident by a previous "cold in the head,"—hoarseness, perhaps loss of voice, soreness referred to the larynx, and irritable cough, coming in spasms and easily excited by a deep breath or by breathing a cold atmosphere after a warm one being its chief signs. Such an attack passes off in a few days. In a more severe form, attended by fever and quick pulse, there is aching or actual pain, and perhaps even pain on pressure on the larynx (Adam's apple) from without. Swallowing increases the pain. The person may at first think the pain is due to a fish-bone that has stuck deep down in the throat. Spasms of coughing occur, the cough being hoarse and rough. The voice is altered, perhaps lost. All this is due to the redness, dryness, and swelling of the membrane. But the swelling in very severe cases may seriously impede breathing by obstructing the passage, and then the breathing is wheezy and whistling. Perhaps the patient gasps for breath and has all the appearance of one struggling against suffocation, the eyes being prominent and face livid and bathed in sweat. If not relieved, the patient becomes delirious and sinks into insensibility owing to the blood being charged with carbonic acid gas. Such acute cases are only found in adults, and generally take such a fatal form because of an enfeebled constitution.

A chronic form of the mild type of laryngitis is the cause of what is called clergyman's sore throat, which is considered under Affections of the Voice at page 390. Chronic forms of the disease, ending in ulceration, attend tubercular consumption and syphilis, and are the cause of hoarseness and loss of voice in these affections.

Treatment.—Hot cloths and poultices should be applied directly over the front of the neck. If these fail to give relief, or if the case be urgent, mustard poultices or blisters may be applied. These, however, should not be placed directly over the larynx, but over the upper part of the breast-bone. The reason is, that if the blisters or mustard were placed directly over the larynx, the swelling they produce would extend to the larynx, because of its nearness to the surface. The person should be in bed in a room kept warm and free from cold draughts. Breathing steam will relieve the irritability of the throat, and to the same end a kettle should be placed on the fire and allowed to pour its steam into the room. For this the bronchitis kettle is best. (See Appliances for the Nursery, Plate XXXI.) Hot drinks are also beneficial; and the bowels should be unloaded by a good dose of salts. In ordinary cases these measures will be sufficient. Persons of weak health must have their strength maintained by nourishing soups. Sometimes stimulants are necessary. But cases of this kind ought to be in charge of a qualified physician. In cases where suffocation is threatened, instant relief may be given by the performance by a surgeon of **tracheotomy**. This consists in opening the windpipe from the outside and inserting a tube. The patient breathes through this new opening till the swelling has subsided, when the tube is withdrawn and the wound closed.

In chronic cases blisters may be applied outside, but the most effective treatment consists in the direct application to the membrane of astringent remedies in the form of spray, powder, or paint applied as mentioned in the paragraphs on Affections of Voice (p. 390).

Dropsy of the Larynx (*Œdema*) is a condition in which great swelling—sometimes threatening suffocation—is produced by the pouring out of fluid from blood-vessels in the loose tissue under the mucous membrane. It is due sometimes to the swallowing of scalding liquids, and sometimes comes on after erysipelas and scarlet fever. It may be caused by inflammation, or be apart from it. It can best be relieved in dangerous cases by tracheotomy, as above mentioned, or by a surgeon passing a lancet down the throat and scraping the part to permit the fluid to escape and the swelling thereby to subside. If scalding has been the cause, relief may be obtained by ice applied to the throat.

Inflammation of the Windpipe (*Tracheitis*; Latin, *trachia*, the windpipe) is very similar to inflammation of the larynx. It also may be a mere accompaniment of a common cold. **Croup** is a special kind of inflammation of the windpipe, and is considered in Section XXIV, p. 538. The ordinary form is accompanied by fever, some pain in the windpipe, spasmodic coughing, &c., as in the affection of the larynx. There is not the same pain in swallowing, however, nor need the voice be affected if the inflammation is confined to the windpipe.

Treatment is the same as for laryngitis.

Bronchitis is a catarrhal inflammation of the bronchial tubes. In it, as in the ordinary catarrh, the lining membrane of the tubes is congested, dry, and swollen. Thereafter fluid is poured out from the gorged vessels, and the secretion becomes, in the later stages, thick and containing matter.

Its causes are chiefly exposure to cold, or the inhalation of irritating substances, or it is due to some fever, whooping-cough, &c.

Symptoms.—There is fever, preceded probably by chills. The pulse is quick, the breathing hurried, and the tongue furred. Appetite is lost; the bowels are confined; there are thirst, headache, and weariness. The special symptoms are due to the condition of the bronchial tubes. They are pain, a sense of tightness in the chest, difficulty of breathing, and a dry, irritable cough. These are due to the congestion and swelling of the mucous membrane of the tubes. The cough is occasioned by the air passing over an irritable surface; and sometimes the patient has a feeling as if a tract within the chest and down the line of the breast-bone were raw. At this time, if one listens with the ear to the chest, whistling, cooing, or piping sounds are heard with the movements of breathing, caused by the air rushing along narrow tubes. By and by the cough is accompanied by a spit of clear mucus, the secretion from the inflamed membrane. The spit soon grows more abundant, and becomes yellowish. The sounds heard in the chest are now not so musical, but more of a bubbling character, called **crepitation**, occasioned by the air passing through the fluid in the tubes. The bubbling is coarse or fine as the inflammation is in larger or smaller tubes. As the case progresses the cough becomes less and the discharges diminish in amount. The sounds in the chest gradually become replaced by the fine rustle of ordinary breathing. The attack may last only a few days, or may go on for some weeks. In what is called **capillary bronchitis** the disease attacks specially the finer tubes. The very young or old are particularly liable to it. Breathing is in this form very difficult and laboured. The patient's skin is livid, and the blue veins are well marked over it, while the distress may be excessive. The spit is not so profuse as in the bronchitis of the larger tubes. It more readily tends to death from suffocation or exhaustion.

Treatment.—The person should be confined to a moderately warm room, the air of which is kept moist by a constant stream of steam from a kettle. A particular kind of kettle—the bronchitis kettle—may be used for this purpose. (See APPLIANCES FOR THE NURSERY, Plate XXXI.) Large warm poultices should be applied to the chest. The bronchitis may be confined to one side, or may affect both. This is determined by listening to the breath sounds. If it is limited to one side the hot applications should be placed on that side only. The poultices may or may not contain mustard, according to the severity of the attack. Let the bowels be opened by a dose of medicine, castor-oil, senna, or seidlitz-powders; and let the food consist of milk, warm broth or soup free of vegetables, beef-tea, &c. This in an ordinary case is sufficient. After mucus has begun to come away it may be aided by a mixture of syrup of squills and ipecacuanha (see PRESCRIPTIONS — COUGH MIXTURES). But let people beware of the ordinary cough mixtures, chlorodyne cough mixtures and the like. They are very valuable in many cases, but they ought to be given with great discrimination. In some cases of bronchitis, where the tubes are loaded with mucus, the constant coming up of which maintains a harassing cough, cough mixtures containing chlorodyne or laudanum will greatly relieve, but *at the expense of letting the discharge accumulate in the tubes to block up the lungs.* If any preparation of opium is given at all, it is only in the early stage, when the cough is violent and excessive, and *dry*, that is, unaccompanied by spit. Then it may be given in 8 to 10 drop doses, with 10 drops ipecacuanha wine, repeated every three or four hours. *It should never be given when the breathing seems obstructed, and the skin and lips have the least suspicion of blueness; indeed its administration should be left entirely to a medical man.* Ipecacuanha may, however, be given in repeated small doses, and specially when the spit is thick and tough. Stimulants are frequently necessary, but are to be given only according to medical advice.

Chronic Bronchitis.—Bronchitis may exist in a chronic form either as a result of an acute attack, as a consequence of long-continued irritation, or as a complication in other diseases. Diseases of the heart or kidneys, for example, or gout, are frequently associated with it. It is mostly in adults, those in middle and advanced life, that it occurs, but it is found also among the young, though it is probably continued in them owing to some bad constitutional condition.

Its main **symptoms** are cough, shortness of breath, and spit. It is particularly apt to attack a person in winter, or during a season of bad weather, continuing until the return of warmer weather, a new attack coming on with the succeeding winter, forming the condition known as **winter cough.** Foggy weather is particularly disagreeable to a subject of chronic bronchitis, a short exposure to the fog usually occasioning the cough and shortness of breath within a very short time. The intervals of good health become shorter, and the duration of each successive attack longer, till perhaps the person is seldom free from some sign of the disease, which is easily aggravated. In such confirmed cases the person becomes markedly rounded in the shoulders, and the chest assumes frequently more or less of a barrel shape. This is partly due to a condition called **emphysema**, in which parts of the lungs become unduly expanded to compensate for other parts rendered more or less unfit for their duty. The discharge from the bronchial tubes of chronic bronchitic patients varies, sometimes being very abundant and watery, or thick and yellowish, sometimes being very scanty. In some cases it is very badly smelling. As a result of the condition of the lungs, other organs frequently suffer—the heart, liver, and kidneys—and death in the end may be due, not only to the lungs becoming more and more unfit for work, but also to the complications, to exhaustion, &c.

Treatment.—The patient should be exposed as little as possible to any considerable change of temperature, and should not go out into the early morning air or night air. Wet and cold feet should be specially guarded against. The body should always be warmly clothed, flannel being next the skin. The room in which the person sleeps ought to be moderately warm. Good, nourishing diet in moderate quantity is necessary. Small doses of stimulants are often valuable, but the need of them must be decided on in each case on its merits, and by a competent person, not according to the person's notions. Tonic medicines are required. The ammonia and senega mixture mentioned under PRESCRIPTIONS—COUGH MIXTURES, will be found valuable. Cod-liver oil, if it can be taken, is very serviceable in chronic bronchitis attended with much spit. Inhalation of the vapour of drugs by one or other of the numerous spray-producers, atomizers, nebulizers, inhalers, now so easily obtainable, may be found useful. Menthol, thymol, creasote, camphor, carbolic acid, compound tincture of benzoin, are among the drugs used in this way. All druggists now sell one variety or other of such appliances, and also solutions of the drugs named ready for use. During an aggravation of the attack mustard poultices should be applied to the chest, or cloths sprinkled with turpentine, on the top of which hot flannel cloths are bound.

If the person can remove during winter to a temperate climate he will be greatly benefited and relieved.

It is probably advisable to add a word of warning to sufferers from this common affection. In their eagerness for relief they will try any remedy that promises to do good. Patent medicines are run after. Now relief to the cough can easily be had. At least preparations of opium will greatly subdue it, but in most cases it will be at the risk of adding to the evil by permitting the bronchial tubes to become charged with secretion that otherwise would have been expelled.

Ulceration of the larnyx, windpipe, or bronchial tubes is not a common result of ordinary inflammation. It may, however, occur in any of these situations during the progress of consumption. The material brought up from the diseased lungs, being of a very irritating character, may produce congestion at various parts of the air-passages in its upward course, and lead to a breach of surface and the formation of shallow ulcers. Tubercles may be present in the mucous lining of the bronchial tubes or other parts of the air-passages, and are also a common cause of ulceration, just as they tend to the formation of ulcers in the mucous lining of the bowels (p. 255). Another special cause of ulceration of the air-passages is syphilis.

Bronchiectasis (Greek, *ektasis*, widening) is the term applied to a condition in which the bronchial tubes are widened in some part of their course. It is a consequence most commonly of chronic bronchitis. One result likely to occur is that the widened tubes retain a considerable quantity of the matter, which is usually copious, and that it decomposes, so that the spit has an offensive smell.

SPASM OF THE LARYNX AND BRONCHIAL TUBES: ASTHMA.

Spasm of the Larynx.—The opening in the larynx, the **glottis** (p. 355) as it is called, that affords a passage for air between the windpipe and upper parts of the throat, is not a very wide opening. It is also capable of being widened or contracted by muscles that surround it. It is when it is contracted to a narrow slit, and air forced rapidly through it, that voice is produced (p. 355). Now the contraction of muscles that produces the narrowing of the opening is effected by nerves, laryngeal nerves; and if these nerves be stimulated in any way the contraction of the muscles, and the narrowing of the aperture of the glottis, will result. In spasm of the larynx the nerves are irritated in some way or other, the muscles suddenly contract, and the opening is greatly narrowed, so that the breath is drawn in with great difficulty. The narrowing may be so great that the opening is entirely closed, and then no air can be drawn in at all. The spasm may be due to inhaling very irritating vapour, or to some irritating substance finding its way into the larynx. We all know how, when something we are eating or drinking "goes the wrong way," there is a sudden feeling of suffocation, great difficulty of drawing breath, accompanied by spasmodic attempts at coughing. The substance has entered the larynx and so irritated it that the glottis has spasmodically closed, while at the same time involuntary efforts to expel the offending substance are made. When the spasm yields there is often a long-drawn shrill sound, to which the term "whoop" is given, accompanying inspiration, due to the air rushing past the still narrow opening. Such spasms of the larynx are features in whooping-cough, so called because the whoop is specially characteristic of the disease, and in other disorders. Sometimes spasm of the larynx is due to irritation of one of the laryngeal nerves, caused by the growth of a tumour pressing on the nerve: it also occurs in hysteria. **Child-crowing** (*laryngismus stridulus*) is a spasm of the larynx. It is discussed under Diseases of Children.

The **treatment** depends on the cause. If irritating vapour has set up a spasmodic condition, breathing of steam is useful as well as hot applications to the throat. In many cases inhaling the vapour of ether or chloroform acts like magic; but it must be superintended by some competent person. In hysterical and nervous cases dashing cold water over the chest causes the spasm to relax.

Asthma (Greek, *asthma*, panting) is an affection due to a spasm of the small bronchial tubes, causing great difficulty of breathing. The bronchial tubes have a middle coat of muscular fibres (p. 343). If they contract they will diminish the extent of passage in the tube. In the walls of the smallest bronchial tubes there are no plates of gristle to keep the tubes open; thus contraction of the muscular fibres will readily narrow them, and, if it be excessive, close them altogether, so that air can no longer pass along the affected tubes till the spasm is relaxed. The amount of contraction is regulated by the nervous system, so that some irritable condition of the nerves supplying the bronchial tubes may occasion tonic contraction of the bronchial tubes, an attack of asthma.

Causes.—True asthma is thus a nervous disease; but the nervous irritation giving rise to an attack may be produced by many causes. It is a disease not unfrequently handed down from parent to child, showing itself perhaps in infancy, and most commonly at least before the tenth year. But it may begin at any period of life. The immediate cause of an attack may be the inhalation of irritating vapour or dust. It is a peculiar disease in this respect that the circumstances exciting an attack vary with each individual who is subject to it. Thus the smell of new-mown hay brings on a spasm in one, in others the smell of some particular flower, or some particular animal, cat, dog, hare, rabbit, &c., or of some particular drug, for example, ipecacuanha powder. Some asthmatics suffer in one kind of atmosphere, others in an atmosphere of a totally different kind. Each person has to determine for himself what is not hurtful to him. Some asthmatics can live in one place for only one period of the year, and must remove elsewhere for other periods. One of the commonest causes of asthma is obstruction of one or both nostrils either by chronic catarrhal swelling or by hypertrophy of bone or mucous membrane. The removal of the obstruction frequently causes the attacks to cease. Stomach affections, specially dilated stomach, are also very frequent causes; of course no treatment which omits to take these things into account is likely to afford permanent cure. A loaded condition of the bowels, states of the heart, liver, and kidneys, may all occasion asthmatic attacks.

Symptoms.—An attack may come on suddenly, or may be preceded by drowsiness and a sense of tightness and constriction in the chest. A peculiar itching of the chin, not relieved by scratching, is in some cases a forerunner of the attack. It commonly comes on at a particular hour, and generally in the middle of the night. The chief symptom is intense difficulty of breathing, which compels the patient to rise from his bed and place himself in the position that will enable him to expand his chest to the utmost for the entrance of air. He throws off clothing, and raises his shoulders; if there is anything above him convenient for the purpose he grasps it with his hands, thus fixing his shoulders in an elevated position and enabling his muscles to act from a fixed point in expanding the chest. Every attitude indicates a struggle for breath. His face expresses great anxiety; his eyes are prominent, his skin pale or bluish, and perspiration breaks out over his body. The breathing is attended with great wheezing.

The spasm may last for only a few minutes or for several hours. It may be present in a mild form for some time. When it passes off, cough comes on, and with the cough a small amount of mucus is frequently discharged, but not in sufficient quantity to account for the difficulty of breathing. It usually recurs at more or less regular intervals or seasons. An asthmatic individual may live to a good age. The disease sometimes disappears in adult life when it has appeared in infancy, but it is usually life-long. Repeated attacks are apt to occasion changes in the lungs, and changes connected with the heart.

Treatment.—In many cases a good dose of opening medicine, or an injection to unload the bowels, given at the very beginning, wonderfully relieves. Many remedies are used during the attack to relieve the spasm. Smoking ordinary tobacco, or, better, stramonium (thorn-apple), sometimes does so. The stramonium is put in a pipe along with tobacco or alone, and a few whiffs taken. Inhalation of chloroform is beneficial, but its administration *must not* be attempted by the patient without some competent person at hand. Nitrate of amyl has recently been largely used with some success. Five drops are placed on a handkerchief, which is held over nose and mouth, and inhaled till the person feels giddiness in the head, and the face is flushed and the eyes red. It ought not to be used by full-blooded persons, and indeed by no one without competent advice, for it may produce unconsciousness from the rush of blood to the head. A patent medicine—Himrod's cure—has proved very useful in many cases. It is a powder, and is burnt, the person inhaling some of the fumes. In the same way an asthmatic person will often find relief from burning in his room paper which has been dipped in a solution of saltpetre and then dried.[1] Relief is sometimes also to be had by taking a mixture containing 10 grains iodide of potassium dissolved in a little water, with 10 drops sal volatile (aromatic spirits of ammonia), 10 drops spirits of ether, and 5 drops tincture of belladonna. This dose may be repeated every six hours. Further, 10 drops of tincture of belladonna, with water only, taken every two or three hours, are of great use in the attack. The dose should be reduced if any bad effects—excitement, &c.—arise. An American patent remedy, Tucker's Cure for Asthma, is, in the writer's experience, a more generally successful remedy than any other known to him. It consists of a liquid, vapourized by an atomizer, a small bottle with an arrangement for producing a spray of such fineness that it does not wet. The tube is placed in the nostril, and two or three rapid squeezes given to the air-ball, the person inhaling the while by the nostrils, and exhaling by the mouth. If the instrument is properly used, something like fine smoke issues by the mouth. Relief is produced almost immediately. Continuance in the use of the remedy may, specially in the young, not only relieve but hinder the attacks. The asthmatic patient should do all he can to diminish his tendency to attacks by taking simple nourishing diet, by keeping the bowels regular, perhaps by an occasional dose of rhubarb to relieve the liver. During the intervals, also, 5 grains of iodide of potassium may be taken thrice daily in water, and may be persevered in if, after some time, it is found to benefit the patient. An asthmatic person should try to discover what sort of climate suits him.

> No asthmatic should ever fail to have the condition of his nostrils carefully investigated as well as the state of his stomach, as a preliminary step to the determination of treatment.

Hay-Asthma (*Hay-fever*) is a kind of catarrh to which some persons, not many, are liable during the months of May, June, and July, and which is supposed to be excited by particles from new-mown hay and other flowering grasses entering the nostrils and air-tubes and setting up inflammation. Attacks have even been induced in persons by dust from dried hay. Dust from powdered ipecacuanha also produces the affection in some.

The symptoms are watering, redness, and itching of the eyes, irritation of the nostrils, accompanied by violent sneezing and much discharge, and similar irritation of throat, with cough, difficulty of breathing, tightness of the chest, sometimes with copious spit, &c.

Treatment.—The best treatment is the avoidance of the exciting cause by the person going to the seaside or to a place barren of grass during the months when the disease prevails. The wearing of a respirator made of a double fold of cambric to intercept the irritating particles is suggested. Hay-asthma is due to some nose disorder even oftener than true asthma. An irritable spot of the mucous membrane of the nose is very often sufficient to ensure the return of an attack at the flowering season. Touching such a spot with the electric cautery, cocaine being previously applied to avoid pain, will often be sufficient to stop an attack. The remedies in use for true asthma are also applicable. Many persons have found relief by taking 3–5 drops of the liquor arsenicalis of the British Pharmacopœia after each meal.

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[1] To prepare the paper, dissolve 4 ounces of nitre in half a pint of boiling water; soak thick red blotting-paper in it, then drain the paper and dry it. Burn, at one time, two or three pieces 4 inches square in the patient's room.

TUMOURS, FOREIGN BODIES, &c., OF THE AIR-TUBES.

Tumours occur in the larynx and other portions of the air-passages. A not uncommon form is that of warty growths in the neighbourhood of the vocal cords.

The **symptoms** are hoarseness and loss of voice, croupy cough, difficulty of breathing, and sometimes spasmodic attacks of obstructed breathing.

The **treatment** is removal of the tumour by a surgeon. In some cases where suffocation is threatened opening of the windpipe is necessary to save life.

Foreign bodies of various kinds are common in larynx, windpipe, and bronchial tubes. It may be something one is eating passes suddenly backwards into the air-passages while the person is talking or laughing; or it may be a coin, pebble, button, or some such thing one has been holding in the mouth, &c. The position of a metallic foreign body may be determined by the Roentgen rays in the same way as is done with a foreign body in the gullet. See Plate VII.

The **symptoms** and appropriate **treatment** are considered in the chapter on ACCIDENTS AND EMERGENCIES under the heading CHOKING.

DISEASES OF THE LUNGS.

INFLAMMATION, CONGESTION, &c.

Inflammation of the Lungs (*Pneumonia*).—This form of inflammation of the respiratory organs attacks specially the air-cells of the lungs, the lung substance itself. A description of the regular form will enable one to understand the nature of the disease.

The blood-vessels of the affected part of the lung are engorged with blood, specially the blood-vessels in the walls of the air-cells (p. 344), and also the vessels in the walls of the passages and fine bronchial tubes communicating with them. The pressure of blood in the vessels causes fluid (serum) to ooze from them and enter the cells and passages. As the inflammation continues, besides serum, other parts of the blood escape, namely, fibrin and also blood corpuscles (p. 292). This material completely expels the air from the affected portion of the lung, which thus becomes heavy and solid, and, being capable of clotting, the material forms a gelatinous mass in the air-cells. In the next stage of the disease this inflammatory material breaks down into matter, which is more liquid, and may be expelled from the air cavities and cells. As it is gradually expelled, coughed up, and spat out, the air spaces become unloaded, and air begins again to pass into them. If the case has pursued an entirely favourable course, the inflamed portion of lung will, after some time, be restored to its former activity and usefulness, with little trace of the serious changes it has passed through.

There are thus three stages in the progress of the disease. The first stage is that of **congestion or engorgement**, the second is called that of **red hepatisation**, from Greek, *hepar*, the liver, because the solidified part of the lung looks like a piece of liver, being red in colour owing to colouring matter of the blood; the third stage is that of **gray hepatisation**, the change in colour being due to breaking down of the contents of the air-cells.

Inflammation attacks the right lung twice as often as the left; and generally it is the lower parts of the lung that suffer, both lungs not often being inflamed at the same time. In the typical form a whole lobe is the seat of the inflammation, the lower lobe usually, but the upper lobes may also be affected. Hence the term **lobar pneumonia** has been used to distinguish from **lobular pneumonia**, which attacks the lungs in patches, separated by healthy lung tissue, and is more common among young children than among adults. The latter form is also called **catarrhal pneumonia**, since it is frequently a termination of catarrh or cold in the chest. It may also be stated that lobar pneumonia is also called **croupous**, because of the fibrinous material poured into the air-cells that characterizes the typical case. In most cases of pneumonia there is some amount of bronchitis (p. 363), owing to the affection of the smaller bronchial tubes. There may be also pleurisy (p. 359), that part of the pleura which is in contact with the inflamed portion of lung suffering with it. When the pleurisy is marked the doubled affection is called **pleuro-pneumonia**.

The pneumonia may not end, however, so favourably as has been supposed. A fatal termination may be due to the extent and violence of the attack, or to weakness, the heart being specially liable to fail because of the extra work thrown upon it in driving the blood through the obstructed lung. A chronic condition may be set up, which is considered later. In some cases, comparatively few, and only in those of very weakened constitutions, who suffer probably from other disease, the pneumonia ends in a part of the lung dying, and breaking down into fetid matter. This constitutes **gangrene of the lung.**

The chief **cause** of the disease is exposure to cold, and specially to sudden considerable variations of temperature, so that it is common in spring. It may, however, arise from extension of inflammation from the pleuræ or the bronchial tubes. Thus a common cold, neglected, may end in pneumonia. Other inflammations—those attending whooping-cough, measles, diphtheria, &c.—may occasion it, while it may arise in the course of other diseases, such as those of the heart, kidney, &c. Inhalation of irritating vapours or particles is another cause. For example, the solid particles inhaled by miners, knife-grinders, &c., are capable of producing it. Drinking a large quantity of cold water in an overheated condition of the body, by driving the blood from the organs of the belly to the lungs, may bring on an attack. Pneumonia, however, has come to be regarded as a disease due to an organism of the micrococcus form (see p. 495), the pneumococcus of Friedländer, which is found in the spit in cases of the disease, and it seems quite certain that in some circumstances of an insanitary kind the disease is infective. It may be that the chill, or other cause to which the disease used to be attributed, acts only as a predisposing cause, the organism being able to flourish in and take possession of the temporarily depressed lung.

Symptoms.—The attack usually commences with fever, preceded in adults by severe shiverings, and sometimes in children by an attack of convulsions. The fever is sometimes very high, running to 104° and 106°. Within a short time, 24 hours or so, the nature of the disease is indicated by pain in the chest, rapid, shallow breathing, and cough, at first dry, but afterwards attended by a characteristic spit. The pulse is rapid, but not so much quickened as the breathing. The face is flushed, perhaps livid, the skin is dry and hot; the tongue is furred; appetite is lost; there is headache; and the urine is scanty and highly coloured. The patient should be made to spit into a dish. What is put up is at first rust-coloured, and so thick and gelatinous that it sticks to the dish and will not fall out though the vessel be turned upside down. This indicates that the disease is in what has been described as the second stage. In a few days the spit becomes more fluid and yellowish. Sometimes, however, there is little spit. Delirium is an occasional symptom, and is rather a serious one if marked. A common symptom is an eruption of watery blisters on the lips. The condition of the lung can be readily ascertained by an examination such as described on p. 358. At the onset of the disease a fine crackling sound is heard, which soon disappears, the usual sound of air entering and leaving the air-cells being no longer heard, and a dull sound being produced by tapping the chest over the affected part, because that part is solid. When the matter begins to be expelled, the return of air is signified by the return of the crackling sound, and progress to recovery is indicated by the gradual restoration of the healthy sounds.

Recovery should begin about the fifth or seventh day by a disappearance of the fever. In about a fortnight the disease runs its course, though it may last only a few days or may be much prolonged.

Gangrene is indicated by the spit being fetid.

Treatment.—The person must be strictly confined to bed in a room kept moderately warm, but having a due supply of fresh air. A dose of castor-oil or seidlitz-powder should be given to open the bowels freely, and an ordinary motion should be obtained daily. Light but nourishing diet is to be administered, milk, beef-tea, &c., and water to quench thirst should not be denied. Occasional large poultices to the affected side, or flannel cloths sprinkled with turpentine, and covered with thick folds of warm flannel, will help to relieve the pain and difficulty of breathing. This is the kind of treatment, and in ordinary cases is sufficient with careful and attentive nursing. The acetate of ammonia mixture may be given (PRESCRIPTIONS—FEVER MIXTURES). In cases of exhaustion or weakening of the heart, stimulants are required, the carbonate of ammonia and senega mixture (STIMULANT MIXTURES), or wine, brandy, or whisky. These are not to be given without occasion. The disease, however, is so serious a one, and the details of treatment depend so much upon the individual affected, that no delay should be permitted in summoning a physician.

During recovery nourishing food, eggs, animal food, &c., are required, and quinine and iron tonic, cod-liver oil, &c., are advisable. For some time after the attack the person ought to exercise great care, since the lung cannot be supposed to recover its ordinary condition for a very considerable time after all signs of disease have disappeared.

Chronic Pneumonia (*Fibroid Phthisis* (consumption)—*Cirrhosis*) consists in a growth of fibrous tissue round the bronchial tubes and air-cells, gradually encroaching on them till the lung tissue is converted into dense, hard material. This newly-formed material in time shrinks, and in this way still further destroys the lung substance. It may also in parts break down, and cavities are thus formed.

Its causes are occasionally preceding acute pneumonia, bronchitis, &c. Inhalation of solid particles, such as miners, mill-stone grinders, colliers, flax-dressers, knife-grinders, stone-cutters are exposed to, may also produce it. It is thus known as knife-grinder's consumption, stone-cutter's consumption, &c.

The **symptoms** are chiefly gradually increasing weakness, loss of flesh, more or less difficulty of breathing, and cough, with or without spit, which is often considerable, however. Sometimes spitting of blood occurs, and dropsy arises from the weakened condition of the heart which the disease produces.

The disease may be prolonged for many years.

Treatment consists in good food, fresh air, removal to a warm and equable climate, and tonics, such as quinine and iron, cod-liver oil, &c.

Congestion of the Lungs is a term in very common use, being often employed where in reality inflammation of bronchial tubes or air-cells is present. Of course congestion is always present in inflammation, the vessels being engorged or congested with blood before the proper features of inflammation have developed. Doubtless in some cases the state of congestion passes off without actual inflammation being developed. But a state of congestion independent of actual inflammation does occur, specially in diseases of the heart and during the progress of fevers. Thus where there is valve disease (p. 319) of the left side of the heart, in particular mitral-valve disease, the blood does not pass onwards into the arteries with due rapidity, and becomes blocked in the auricles. The overfull condition passes backwards along the pulmonary veins (p. 302) till the lungs are reached, and there the vessels in turn become overfull, so that the pulmonary blood-vessels are engorged. Fluid escapes from them and pervades the lung tissue, which becomes dark, empty of air, and dropsical. This is apt to lead to active inflammation or to gangrene (death) of parts of the lung. Blood-vessels may burst and bleeding occur, the blood being partly expelled by the mouth, and partly poured out among the lung tissue, forming **pulmonary apoplexy.** Such congestion is not active but *passive*, the blood simply collects because it cannot pass onwards. In fevers, especially exhausting fevers like typhoid, the heart shares in the general weakness, and may become unable to propel the blood with sufficient vigour, so that congestion arises through enfeebled circulation. Old persons, or persons of weak condition of body, if kept lying in bed on the back for any length of time, as for example with a broken leg, &c., are liable to congestion, simply because the weight of the lung itself, with the person in the recumbent position, prevents due circulation. Such persons ought to be propped up occasionally to avoid this.

The **symptoms** are difficulty of breathing, perhaps bluish appearance of skin, and cough, with blood-stained watery spit.

Treatment.—The condition is a serious one, and calls for immediate attention and careful treatment, for one cannot tell how extensive the congestion may become in a short time. Treatment may require to be directed to the heart to strengthen it. Stimulants may be necessary. There can be no harm in the use of warm applications to the chest, specially low down on the back. But skill and knowledge are requisite to determine in each case the cause of the condition and its appropriate treatment.

Spitting of Blood (*Hæmoptysis, Bleeding from the Lungs*) is to be carefully distinguished from vomiting of blood, in which case the blood comes from the stomach, is commonly dark from contact with the acid juice of the stomach, and is mixed with the contents of the stomach. In hæmoptysis the blood comes from the lungs or air-passages in them, and is expelled by coughing. It may be present in the spit merely as spots or streaks, or it may uniformly colour the spit, or it may come in clots, or in gushes of bright blood, frothy because mixed with air. Where it rushes out in quantity no effort at coughing may exist, or there may be but a slight cough. It must be observed that streaks of blood may be present in the spit and not come from the lungs at all, but from the back part of the nostrils or the pharynx, and may, consequently, mean little or nothing. Further, bleeding may take place from the nostrils so far back that the blood finds its way into the back of the throat, and is expelled by a very slight effort. The true nature of such cases will be revealed by an examination of the back of the throat with a strong light, when a fine line of blood is likely to be observed down the back wall of the pharynx from above.

Bleeding from the lungs may be the result of many varied diseases, such as congestion, inflammation, or ulceration. It may be apparently the first occurrence in an attack of consumption. Persons may be repeatedly attacked with hæmorrhage from the lung and no special sign of lung disease be discovered. The bleeding may return at intervals, and consumptive disease not show itself for years. At the same time consumption may speedily follow the first attack. Bleeding is also a frequent occurrence in the progress of consumption, vessels being opened into by the destructive process. In pneumonia (p. 368) loss of blood from the congested vessels gives the rusty appearance to the spit, and in bronchitis streaks of blood in the spit are not uncommon. The bursting of an aneurism (p. 324) into the lungs, or one of the bronchial tubes, will occasion profuse bleeding, the patient dying speedily. Cancer also causes bleeding.

Where the loss of blood is considerable the nervous shock to the patient is usually great.

Treatment.—A person who has suddenly coughed up a considerable quantity of blood should be put to bed, the shoulders being raised. The room should be cool and perfectly quiet. Ice in small pieces given for sucking aids in checking the bleeding. The best medicines are dilute sulphuric acid (30 drops every three hours) in water, gallic acid 10 grains, every two or three hours as long as necessary, or ergotine 3 to 5 grains repeated as required, or ½ to 1 tea-spoonful of liquid extract of ergot instead.

Stimulants are not, as a rule, advisable, tending, as they do, to excite the heart, and so increase the bleeding. Food should be given *cold* for some time after the bleeding has ceased.

If the attack comes as a surprise to the patient, who has seemed a moderately healthy person, it should induce him or her to have a careful examination made of the lungs and heart specially, and its warning should not be disregarded.

DILATATION AND COLLAPSE OF THE LUNGS.

Dilatation or Emphysema (from Greek, *emphusao*, to dilate) is a condition of all or parts of the lungs in which the air-cells are larger than usual, being greatly distended. The walls of the air-cells have lost their elasticity, so that they cannot recover from undue stretching. The condition is the result of some excessive pressure exerted on the walls of the cells by the air within them. It is a common consequence of blocking up of parts of the lung. If the chest enlarges as usual the parts of the lungs that have become blocked up cannot receive any of the entering air, and the healthy parts must consequently stretch to make room for it. If the unusual state continues for any time, the permanent overstretching of the walls of the air-cells destroys their elasticity, so that, if they had the opportunity, they could not recover themselves. It is a consequence of bronchitis, of blocking up or destruction of parts of the lungs, and of other diseases. It may be originated by constant playing of wind-instruments, and by the efforts to raise heavy weights. Though a disease of adults, children affected with croup, whooping-cough, &c., are liable to it.

Its **symptoms** it is needless to discuss, the chief being shortness of breath. It develops a barrel-shaped chest.

Its **treatment** is mainly such as will tend to support and nourish the body, improve the general health and condition of the blood. Nourishing food and attention to the bowels are thus of the utmost importance, and to these is added the administration of iron tonics and cod-liver oil.

Collapse of the Lungs (*Atelectasis*, Greek, *atelēs*, imperfect, and *ektasis*, widening).—The air-cells are empty of air and their walls collapsed, so that the part of the lung affected is more or less shrunk and solid. This may be effected by pressure, for instance by the pressure of a great quantity of fluid in the pleura as in pleurisy (p. 359). It may be present in bronchitis and other diseases of the lungs owing to plugs of matter occupying bronchial tubes and acting like ball-valves, permitting air to leave the part of the lung which the tubes supply, but none to enter. Children during the first year of life, especially the weakly and ill-nourished, are specially apt to suffer from this affection in the progress of measles, whooping-cough, or croup.

Atelectasis is the term applied to the condition of the lungs of children who have not breathed after birth—the air has not entered to expand the air-cells.

The detection and treatment of the condition are the work of a physician.

TUMOURS.

Tumours of various kinds have been found in the lungs. **Cancers** and other malignant growths are not uncommon, leading to destruction of lung tissue, and sometimes eating into blood-vessels, causing death by bleeding.

INJURY OF THE LUNGS.

The lungs are sometimes implicated in wounds of the chest. A fractured rib, for example, may wound the lung and cause spitting of blood. In such cases bandaging the chest to pervent movement of the injured part, or the treatment by strips of plaster as recommended for broken ribs (p. 90), is desirable. Difficulty of breathing, spitting of florid and frothy blood, are among the symptoms that indicate the affection of the lungs. The patient should be kept quiet, propped up in a half-sitting position, and remedies noted under HÆMOPTYSIS (p. 370) should be used.

CONSUMPTION (TUBERCULAR DISEASE OF THE LUNGS).

THE NATURE OF CONSUMPTION.

Consumption is now recognized as a disease due to infection by an organism, the tubercle bacillus (see p. 501). The organism can be found in the spit of consumptive patients, can be isolated from it, can be grown apart from other organisms, and the pure culture of the organism thus obtained will reproduce the disease if introduced into the body of man or animal. See Plate XXI.

The opportunities of infection must be extremely numerous. One has only to consider the large number of persons suffering from consumption and the myriads of the organisms expelled from their bodies in the spit from the lungs, which when the spit dries may be everywhere disseminated in the air in dust, to perceive that wherever there is a crowded population the chances of infection must be many. It has been calculated that one consumptive patient may discharge in the spit 20 millions of bacilli daily. The presence of living virulent organisms in dust has been clearly proved by experiment. In England and Wales the death-rate from consumption in the years 1891 to 1894 was 15 for every 10,000 living. But in London alone, between the years 1897 and 1899, the proportion of deaths from all kinds of tubercular disease, between the ages of 20 and 25 years, was over 40 per cent. But about 38 of that 40 per cent was due to tubercular disease of the lungs alone. Although these facts do not apply to the same years, nevertheless they illustrate how density of population affects the amount of the disease.

There is a quite conclusive amount of facts of this and other kinds to show that man himself is the chief agent in disseminating the infection, and that he does this by the spit from diseased lungs. There are, however, other sources of infection, chiefly meat and milk.

Tubercular disease is widely prevalent among animals—cattle, rabbits, monkeys, guinea-pigs, —but specially so among domesticated animals. The milk of cows affected by tubercular disease in any part of the body is infective, and so also is the flesh of tubercular animals. The identity, however, of tubercular disease of cattle and that of man has been lately denied by Koch, one of the greatest authorities on the subject. This part of the question, however, is still under investigation, and the only safe view is that tubercle in man and animals is the same, and that the meat and milk of tubercular animals is a source of human infection.

It is certain, however, that the organism is destroyed by a temperature considerably below that of boiling-point, and that proper cooking of the meat, and heating milk to a point just below that of boiling, will destroy any infective quality.

The opportunities of infection, then, specially in crowded towns, are numerous. Why is the disease not even more wide-spread than it is?

This is partly due to the fact that the tubercle bacillus flourishes within a comparatively narrow range of temperature, between 80° and

Plate XXI

THE ORGANISM OF CONSUMPTION
(*Tubercle Bacillus*)

As found in the Spit of a Consumptive Patient

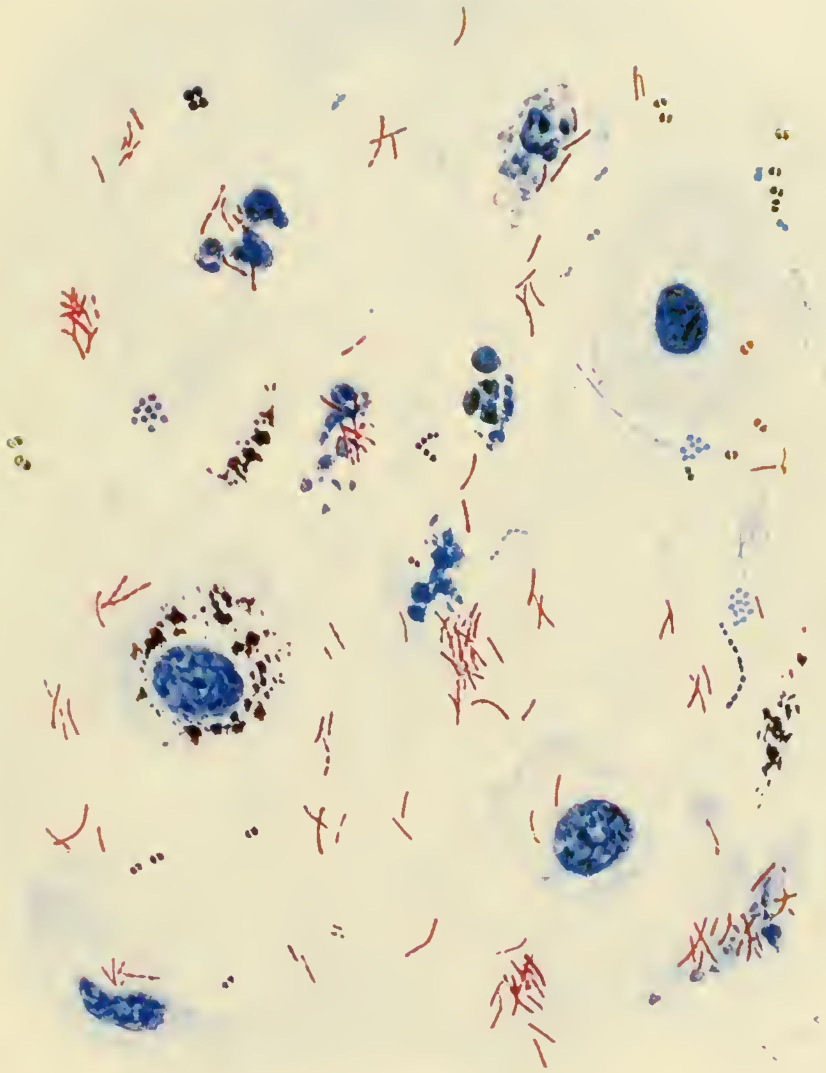
This plate affords an excellent illustration of the methods of modern medicine.

This is an accurate reproduction from a drawing in colours of the appearance under the microscope of the spit of a consumptive, treated in a particular way.

A very fine layer of the spit is spread on a microscopic slide. This is allowed to dry in air, or is dried over a spirit-lamp; a solution of magenta is then spread on the slide, and the slide gently warmed. After five minutes, the magenta solution is washed off, and a solution of methylene blue made acid with sulphuric acid is poured on, and allowed to act for fifteen to thirty seconds. It is then washed off thoroughly. The slide is then dried over a spirit flame, the stained film is rendered transparent with xylol, a drop of Canada balsam solution is placed on it, and over that a cover-glass. The film is then examined under a microscope, and the plate shows a field as seen under an oil-immersion lens, magnifying by 1000 diameters.

Clumps of beaded rod-shaped structures, stained red, are seen in a faintly bluish field. Large rounded bodies are seen, faintly blue, with deeply blue-stained masses in the centre. These blue-stained bodies are cells from the air-spaces of the lungs, and from the air-passages. The red-stained rods are the **tubercular organisms**. They are here in great numbers. Other organisms are seen, minute round dots, in groups, in single file, in twos, in fours. These are **micrococci** (see p. 495), suggesting that in the areas of lung attacked by consumption, other changes are going on of a pneumonic and putrefactive kind.

It will easily be understood of what value this method is in determining whether a patient, troubled with cough and spit, is suffering really from consumption. The discovery of even one or two of these red rod-shaped organisms in the expectoration would go far to settle the question in the affirmative.



(21)

THE ORGANISM OF CONSUMPTION

(*Tubercle Bacillus*)

106° F., and does not therefore multiply outside the body; direct sunlight destroys them in a few minutes; and ordinary daylight and fresh air are destructive to them.

If, then, consumptive patients were universally to cease expectorating carelessly anywhere, and were constantly to use spit-bottles or flasks which were regularly disinfected, if the meat of tubercular cattle were rigorously destroyed, if it became the universal practice to heat milk before use, if town and county authorities were to insist on air-spaces being strictly maintained between dwellings, and were to secure the abolition of back-lands, of ill-lighted and ill-ventilated tenements, workships, and factories, this disease might soon become as rare as small-pox. It has, indeed, already been shown that a considerable decline has of recent years taken place in the deaths from consumption, due to the improved sanitary conditions in which the people live.

Individual Susceptibility to Consumption.—There is still another element to be considered in answering the question why consumption, considering the chances of infection, is not even more frequent than it is; that element is the natural resistance of the body to the disease. This natural resistance will vary, not only in different individuals, but also in the same individual at different times. To put it in other words, one person is more susceptible than another. The susceptibility will vary, as it does in other diseases, with temperament, type of constitution, with habits, occupation, and so on; and in the same individual the susceptibility will vary from time to time as the general vigour and robustness of the person varies. The chief circumstances that affect susceptibility come under the following heads.

Age.—While the disease may occur at any age, fully one-half of the fatal cases are between the ages of 20 and 40. It is less frequent in childhood and in old age. It must be noted, however, that while tubercle of the lungs (consumption of the lungs) is rare in childhood, tubercular disease of glands is common, and specially of the glands of the belly, causing consumption of the bowels, and tubercular disease of the brain (water-in-the-head).

Occupation.—Persons like knife-grinders, miners, stone-masons, &c., exposed to irritating dust-particles, are frequent victims. The occupation may lead to exposure, to confined habits of living, to loss of exercise, &c., and so favour the occurrence of the disease. Occupations that compel the body to be kept in constrained positions, especially such as hamper the breathing, stooping constantly over a desk, for example, are injurious. On the other hand, occupations compelling active life in the open air increase the natural resistance of the body, and occupations that compel active exercise of the lungs, as for instance flute- or other wind-instrument playing. Thus one could speak of a general and a local susceptibility. For instance, a general state of depressed health would make one susceptible to anything, including an attack by the tubercle bacillus, but persons exposed to the breathing of air laden with dust may enjoy perfect general health, while there is increased local susceptibility of the lungs because of the local irritation there. So one can increase the natural resistance of the whole body by active life in the open air, and one could increase, in particular, local resistance to consumption by chest and breathing exercises, as the wind-instrument player of necessity does.

Habits and Mode of Living.—Intemperance and other irregularities of life, and excess of various kinds, by their general effect on the body, are predisposing causes. In a similar way defective nourishment arising from bad or insufficient feeding, or from faulty digestion of one kind or another, has a very powerful influence.

Surroundings.—Breathing an impure atmosphere, such as is common in the small and ill-ventilated homes of the poor, too common also in workrooms of tailors and seamstresses, is a very favourable condition for the development of consumption. A damp soil and a moist atmosphere are also favouring conditions. A variable climate and a cold locality are bad. The value of active exercise and an open-air life has been already referred to.

Hereditary Influence.—Until the infective nature of consumption was fully established, hereditary influence was supposed to be the chief determining cause of consumption. It was a disease which "ran in families," and to have a consumptive father or mother was supposed to ensure that one would develop consumption sooner or later.

> It cannot be too emphatically stated that this view must now be abandoned. Consumption is an acquired, not an inherited disease. It is, indeed, in essence, and at first, a local disorder and not a constitutional disease, though it may become a general disorder.

It is true that while the real cause—the tubercle organism—of the disease was unknown, the facts all seemed to show conclusively that it was a disease transmitted from parent to child. If one, however, remembers the facts that have been stated, it is easily seen how, no precautions being taken, it would be difficult for children to escape if a father or mother were affected with the disease, and how easy it would be for one child to infect another. These facts show that what was for a long time believed to be a family tendency is as easily accounted for on the infection view. The same facts indicate the means by which, if one member of the family becomes attacked, the other members may be protected. These means will include the separation, altogether if possible, of the infected member of the family. If complete separation is impossible, the adoption of precautions, such as a separate room for the infected person, the use of disinfectants, the disinfection of the spit, &c., will go far to prevent infection of the others.

It is impossible in a work like this to go into detail in the way of showing the proof of the facts that have been stated. It is only possible to note without qualification the practically accepted views that now prevail. But how difficult it may be to distinguish between an inherited disease and an acquired one may be illustrated in consumption.

It has already been stated that the milk of a cow, affected in any part of the body by tubercular disease, may be infective. Similarly the milk of a nursing mother or wet nurse may be infective, and the infant at the breast may thus become tubercular. But infants are not susceptible to tubercle of the lungs. This is paralleled by a similar fact of another infection, namely scarlet fever, to which infants of less than one year of age are little liable. But an infant infected by the milk of a tubercular mother may afford a resting-place for the organism in the glands, those of the neck, for instance, or bowel, and there the disease may lie quiescent for years. Then when the child has grown up, the organism hitherto quiescent may become active owing to some other circumstance, may multiply and pass from glands into blood-vessels, so reach the lungs, take root there, and produce consumption. This case, by the old view, would be a proof of the inherited tendency, whereas it is only an illustration of a well-known fact of the tubercular infection, that it may long lie dormant. Incidentally, therefore, we have emphasized the need of another precaution, namely that a consumptive mother should not suckle her children.

It must, however, be noted that there are certain types of constitution more liable to attack than others. This is, of course, true of every disease. Everyone could probably give illustrations from their own knowledge of families that seemed to fall a prey to every infection going, and other families that seemed to be proof against even the commonest infection. So there is a type of constitution more liable to tubercle than another, a type of light build, clear complexion, light-coloured hair, bright eyes, quick and active but not muscular. Inheritance also affects the power of resistance, as is shown in the offspring of too early marriage, or of marriage between persons too nearly related, or between persons of considerable difference of age.

In short, a person may *be born with* a delicate constitution and with a strong tendency to the disease; an ordinarily healthy individual may *acquire* a weakened constitution owing to his occupation, surroundings, as a result of various diseases, or owing to the pressure of poverty, anxiety, overwork, &c.; and a person may *acquire* a weakened constitution by his habits, by excesses, undue and prolonged excitements, &c. In all these persons the natural resistance of the body is lessened, and, amid the numerous opportunities of infection, they sooner or later fall victims to the attack of the organism.

The Site of Attack.—The disease begins most commonly in the upper part of the left lung, about the level of the middle of the collar-bone, spreading backwards into the apex from this place. Sometimes the first part attacked is the apex of the middle lobe; this corresponds, on the outside of the chest-wall behind, to an area between the middle of the posterior edge of the shoulder-blade and the spinal column. Another place where the disease manifests itself early corresponds to the side wall of the chest, about the middle when the arm is raised.

Changes in the Lungs.—The tubercle bacillus then, introduced in one way or other into the lungs, settles down in the lung tissue, and, if it flourishes at all, goes on to produce certain changes. What the precise nature of these changes is, and whether they occur quickly or slowly, will depend on the number and virulence of the organisms and on the amount of resistance the person in general and the lung tissue in particular offer to their operations. The result is that while the changes produced in different individuals have all certain characters in common, the manifestations of the disease in each individual may vary considerably, being rapid in one and slow in another, one symptom being prominent in one person, and another in another person. Moreover, in one person the reaction of the lung to the operation of the organism may vary in kind or degree from that of another person, and thus the extent and character of the changes will present different features in different individuals. In consequence of these differences different types of disease have been described, at different times and under different names, either according to the prominent symptoms during life, or the appearances of the diseased lungs after death, which are now recognized as merely due to varieties of operation of the same cause, and all capable of being included under the general term of consumption of the lungs, or tubercular disease of the lungs, or wasting of the lungs, or pulmonary phthisis. Thus while tubercular disease of the lungs is a term applied to the disease when one thinks of its cause, decline or consumption is a more popular term, applied because of the prominent symptom, in numerous cases, of loss of strength and flesh, or because of the apparent breaking down of the lung and the matter that is expelled in the spit. The nature of the changes we shall indicate as briefly as possible.

The tubercular organism causes around it a growth of cells, some large ones and numerous small ones, so that the organisms come to lie in and among a mass of round cells. This mass pushes aside and usurps the place of the healthy tissue. It is about the size of a millet seed and has a clear gray appearance, the **gray tubercle.** But there are no blood-vessels in this mass; it is therefore of low vitality, breaks down in the centre, and degenerates into a yellowish cheese-like mass. This is called the **yellow tubercle.** Here the process may stop, and the little caseous mass may further become walled off from the healthy tissue around by the conversion of a zone of round cells into fibrous tissue. The cheesy mass may shrink and be absorbed, or it may be infiltrated with lime salts and become chalky. This is to be regarded as a process of cure, the resistance of the tissue having triumphed, and there is only left a patch of fibrous tissue—a scar—or a nodule of chalk to mark the spot where the battle was fought. On the other hand, the mass may continue to grow, one mass may coalesce with another. They may soften and liquefy, burst and be discharged, the matter being expelled in the spit, and a cavity may be thus left in the lung substance. The process going on in the walls of a cavity, it enlarges, several cavities communicate with one another, and the lung may thus become riddled with small or large or irregular cavities. Such a mass may break down and discharge through a bronchial tube, or form and break down on the wall of a tube, leaving an ulcer. But even though a cavity has been formed, or several cavities, the active process may cease, lung tissue become condensed round the wall of the cavity, which shrinks, and, the fibrous tissue round it gradually contracting, it may be more or less obliterated, the site being again marked by an irregular fibrous patch.

But the presence of these tubercular nodules is irritating to the healthy lung tissue in the neighbourhood. This irritation causes an excessive flow of blood to the neighbourhood, and an inflammation is produced with the characters of a pneumonia, the air-cells of the affected area becoming filled up with inflammatory material from the engorged vessels. Thus if these tubercular nodules are numerous an extensive area of the lung may, by their presence, become involved in a pneumonic process, so that the whole area, because of the filling of the air-cells with inflammatory material, added to the numerous solid tubercular nodules, becomes converted into a solid liver-like mass. This is spoken of as **consolidation of the lung.** A case of this sort will be difficult to distinguish from one of simple pneumonia, at least at first. But whereas in simple pneumonia the material filling the air-cells liquefies in a few days and is expectorated, leaving the air-cells still intact, in that form of pneumonia which is really only an incident of the tubercular process, the breaking-down process involves the lung tissue itself, and the recovery of the patient does not take place as in the simple inflammation. This might be called a tubercular pneumonia, but it is really only a type of consumption in which one feature has become prominent. In the same way the tubercles may by their situation cause congestion and irritation of the bronchial tubes, and the prominent symptoms for a time may be of bronchitis only, such as cough and the expectoration of clear mucus, or cough only.

This is doubtless the explanation of numerous cases where the person is said to have contracted an ordinary cold, or to have had a severe chill, out of which consumption developed, the truth probably being that what was supposed to be the chill or common cold was really the early manifestation of the tubercular process itself.

In the main, then, the chief features of the changes in the lung are: (1) the formation of the tubercular nodules, numerous or few, localized in parts of the lung or scattered freely among its substance, (2) the conversion of these nodules into cheesy material—caseation of the nodules,—(3) the subsequent liquefaction and discharge of the matter, and hence (4) the formation of cavities or (5) their conversion into fibrous patches by a process of cure, (6) the attendant inflammation of healthy lung tissue in the neighbourhood. The predominance of one or other of these features will determine the type of the disease and the character of the symptoms. The true nature of the disease when, because of the predominance of one symptom or another, it assumes at first the appearance of a pneumonia, a broncho-pneumonia, or a bronchitis, will frequently be revealed by the discovery of the tubercular organism in the spit.

In some cases the progress of the disease may be slow, because of the less virulent nature of the organism, or the persistent resistance of the body in general or the lung tissue in particular. In such cases the tendency of the resistance of the lung takes the form of surrounding the tubercular nodule with a fibrous wall, limiting its growth and activity, and where this tendency has time to keep pace to some extent with the tubercular growth, considerable areas of lung substance may be converted into fibrous tissue. This, though in a sense a process of cure, nevertheless destroys the true lung substance by replacing the air spaces by patches and strands of fibrous tissue, the shrinking of which still further compresses the lung tissue and destroys its capacity to expand with air. In such a case the ordinary symptoms of consumption may not be present, expectoration of matter, for instance, and may be replaced by increasing difficulty of expanding the chest and breathlessness, but it is still a variety of the same disease.

Similarly, tubercular nodules situated in the lung near the surface, or actually on the pleural lining, may produce by their irritation all the symptoms of a pleurisy, with or without effusion, and a suspicion of the true character of the disease may only arise because of a long continuance of the disease and failure of the signs of recovery to show themselves at the usual time. Technically this would be a tubercular pleurisy, but the variety of the disease is only due to the accident, so to speak, of the situation of the tubercular nodules at the commencement of the illness.

The Tubercular Poison or Toxin.—The changes that have been described are actual changes in the structure of the lung, of a destructive kind. But there can be no doubt that the tubercle bacillus, by its life and growth and activity, produces material foreign to the body, capable of acting as a tissue poison. Substances of this character can be detected in pure cultures of tubercle, so that though the broth or gelatin in which the organism has been grown may be freed from all living organisms by boiling and filtration, it is yet poisonous because it contains in solution products of the life of the bacillus. There is no doubt that some of the symptoms of tubercular disease are due to the poisonous effects of such substances, produced in the tissues where the bacillus is multiplying, and distributed to all the tissues of the body by the blood stream.

Infection of other Organs.—The expectoration is infective, and, as might be expected, in its course upwards, through bronchial tubes, windpipe, voice-box, throat, and mouth, it may infect at any point. Thus ulcers occur in the walls of the air-tubes, on the vocal cords, or about the tongue and tonsils. Of course all these parts may be the seat of tubercular ulceration due to deposit of tubercle upon them in the first instance. As a result of swallowing of the sputum, infection of the bowel is almost certain to occur sooner or later, and the whole digestive tract may be in a more or less catarrhal condition, due to irritation. Tubercular ulceration is commonest about the end of the small bowel. The growth of the ulcer may eat its way through the bowel-wall and set up a general and fatal peritonitis. Many cases of appendicitis are no doubt tubercular in origin, and bleeding from the bowel is frequently due to the erosion of a blood-vessel by the ulcerative process.

We may now go on to consider a few of the leading types of tubercular disease of the lung, bearing in mind that these types are not dependent upon any essential differences in the real character of the affection, but are caused by the varying manifestations of the disease, dependent upon entirely secondary and subordinate circumstances such as have been discussed.

TYPES OF CONSUMPTION.

Acute Tuberculosis of the Lung may occur as part of a general infection of the body by tubercle, or the disease may be limited to the lung. In its typical form it bears no resemblance to an ordinary case of consumption, but affects the patient in a way strongly suggestive of a specific infectious disease. Thus for a time it may be considered an attack of typhoid fever. This is probably due to the fact that the symptoms are not so much due to the changes going on in the lungs as to the poisoning of the patient by the toxins produced by the organism (p. 376), the organism being a virulent one, or attacking in great numbers or spreading with great rapidity. In such cases the lungs (probably both are affected) are found sown everywhere with the gray miliary tubercle, and the patient may die, overwhelmed by the attack, before any of the ordinary changes in the lungs have time to be evolved, and before the symptoms recognizably consumptive have appeared.

The **symptoms** of such a type are fever, which runs high, and which probably oscillates daily, being highest about 6 afternoon, and lowest about 2 or 3 in the morning, the maximum being 103° or 104°. The pulse is rapid and weak, the breathing is quickened, and may be so embarrassed that a tinge of blueness is visible on the skin. There may be no cough, and little or no expectoration. On the other hand, the cough may be distressing, and of a dry irritable character. Loss of flesh and strength is rapid and marked. There is loss of appetite, perhaps with a feeling of sickness, and maybe vomiting. The tongue is coated, and becomes quickly dry and brown. The bowels may be undisturbed. Delirium and stupor set in, and death may occur in a few days or weeks. All this time, while the lung may be the only part attacked, it may be very difficult to detect any marked change in the character of the breath sounds, &c., when the chest is examined. It may be noted that this form of attack may occur in a person who has been long tubercular or consumptive, due to a sudden wakening to activity, so to speak, of the tubercular organism, which has been lying latent in the patient's body.

Other cases may follow a less acute course than the above. In some the fever may be less noticeable and occur only in the afternoon, the exhaustion and emaciation being the chief features. Indeed in some cases there is nothing to be noted except profound weakness and loss of flesh. It is, however, often in such cases that there is bleeding from the lung, the scanty spit being stained with blood, or frequent hæmorrhages taking place.

In **chronic forms** of the same type emaciation is the leading symptom, and the patient may be subject to recurring attacks, at one time of what seems pneumonia, at another pleurisy, at another a spitting of blood.

The detection of the true nature of the disease in this type of consumption is often extremely difficult. A correct opinion is likely to be formed only when the temperature is regularly taken and recorded, when the chest is repeatedly and carefully examined, when any spit that can be got is stained and examined for the tubercular organism, and in the very acute cases the blood should be tested for the reaction of typhoid fever.

Galloping Consumption (Acute Phthisis—*Phthisis Pulmonalis acuta*).—It is in this type of consumption specially that the air-cells of the lungs become filled with inflammatory products and the tubercular nodules undergo the cheesy conversion, and ultimately both break down and liquefy, so that numerous cavities are formed throughout the lung substance. Probably because of the rapidity of the process there is little of the formation of fibrous tissue surrounding the tubercular masses. The features, then, of this type are the easily-discovered changes in the lungs themselves, and the corresponding symptoms of lung destruction, which makes the disease recognizable to the patient and those about him.

Symptoms.—The patient is suddenly attacked by what at first is called a feverish chill. This fever oscillates, as in the preceding type, and the pulse is quick. There is rapid loss of strength and flesh. Profuse sweating is frequent, specially at night—"night sweats." There is often pain in the side, and cough with spit, at first suggesting pneumonia, and quite early in the attack much blood may be coughed up. Within a few days the changes going on in the lungs can be discovered by examining the chest, and a microscopic examination of the spit will make clear the nature of the disease. The breathing is rapid. As the lung tissue breaks down, the spit becomes more abundant, of a yellowish-green colour, and if expectorated into a dish with a little water, it floats in small round clumps, the nummular spit of consumption. If considerable cavities have formed, the cough will come in bouts, a large quantity of yellowish, and perhaps sickly-smelling matter being put up at a time, the cough then ceasing for a time. The case goes on from bad to worse till death occurs, maybe in a few weeks, from exhaustion. There are numerous cases of this same type only less acute, or in which a less extent of lung is involved. In the latter case the disease may cease in the area of lung attacked, fibrous tissue may form to surround and obliterate the tubercular nodules or cavities, and the person may recover with this part of the lung permanently damaged but without active disease going on. In such a case the fact will be revealed even to the eye in the flattening or indrawing of the chest-wall over the site of the impaired piece of lung.

Chronic Consumption.—In other cases the changes in the lung, while of the same type as those in acute consumption, go on more slowly, invading one part of the lung after another, crossing over from the lung first attacked to the other. Such patients may go about, except when laid up by a fresh more acute outbreak. In such cases bleedings from the lung are apt to be frequent, because of erosion of vessels in the walls of cavities. Often the case may end by the opening into a large vessel and violent hæmorrhage. Night sweats are more frequent in this form of the disease. In its course also a great variety of symptoms may occur, dependent upon the direction in which the disease is extending. Thus pleurisy and extensive effusion may occur, and, if any cavity opens into the pleural space, matter may form, and the condition called **empyema** arise, requiring operative interference.

In the progress of the disease other symptoms indicate that various other organs are affected. Notably in advanced phthisis is looseness of the bowels common. In some cases it is most intractable, increasing the exhaustion of the patient with great rapidity, being due to deposit of tuberculous matter in the bowels, and it may be accompanied by pain in the belly.

Fistula in the anus (p. 269) is frequent in consumptive patients, and the healing of the fistula has, in many cases, been followed by rapid progress of the disease. On this account, though it is curable by a surgical operation, many, who fear consumption, prefer to leave it alone.

Alterations of voice, hoarseness or loss of voice, due to tubercular ulceration in the larynx, occur in the course of the disease. Whether this is the cause can be determined by an examination with the laryngoscope (p. 356).

Confirmed consumptive patients may be known by certain curious physical characters: clubbed form of the ends of the fingers and the nails, pearly-white colour of the white of the eye, wide condition of the pupil (the black of the eye), and the presence of a reddish or purplish line along the junction of the gums and teeth.

Death is due commonly to exhaustion, but may occur suddenly owing to great loss of blood by the lungs, or may be caused by some complication. Dropsy, occurring usually in the feet and legs, and the presence of thrush in the mouth are signs of the approach of the end.

The very varying duration of consumptive disease is shown by the following table, which gives the results of 314 cases:—

24	died	within	3 months.
69	,,	between	3 and 6 months.
69	,,	,,	6 ,, 9 ,,
32	,,	,,	9 ,, 12 ,,
43	,,	,,	1 year and 18 months.
30	,,	,,	18 months and 2 years.
12	,,	,,	2 and 3 years.
11	,,	,,	3 ,, 4 ,,
5	,,	,,	4 ,, 5 ,,
1	,,	,,	5 ,, 6 ,,
3	,,	,,	6 ,, 7 ,,
1	,,	,,	7 ,, 8 ,,
3	,,	,,	8 ,, 10 ,,
11	,,	,,	10 ,, 40 ,,

Fibroid Phthisis is a form of consumption which is characterized by the formation of patches and strands of connective tissue—fibrous tissue—replacing the tubercular nodules, in which the more imminent symptoms are of loss of breath, and laboured breathing on exertion, the other symptoms of ordinary consumption being less marked. (See p. 370.)

THE GENERAL TREATMENT OF CONSUMPTION.

For a disease of so much variety of symptom and complication and emergency, it is impossible to lay down anything but the most general lines on which to proceed.

General Rules.—The consumptive should live a methodical, regular life.

The diet should be generous, rather than restricted, should contain abundance of milk, eggs, bread, and butter, as well as meats, vegetables, and fruits. The meals should be separated by 4 or 5 hour intervals.

The bowels must be kept regular, for which a rhubarb pill or tabloid will suffice.

Clothing should be regulated by the weather, flannel or woollen always being next the skin. Care should be taken that the feet are well protected by stout boots when the patient is able to move about. Women should abandon corsets and all tight clothing that restricts the play of the chest, and should never wear low dresses.

Bathing of the skin should be regularly attended to; sponging the whole body down with tepid water and following with a good rub being daily performed. Bathing in the open is to be avoided.

Occupation.—As far as possible fatigue should be avoided. Consideration should be given to the character of the occupation, specially as regards its freedom from dust, and the ventilation and openness to sunlight of the place where it is carried on.

Exercise in the open air is desirable, if possible, but it must be regulated by its effects on cough and temperature. No violent exercise should be engaged in, and nothing involving strain or holding the breath. Cycling must be prohibited.

The home of the consumptive should be selected, as far as circumstances permit, in as open a district as possible, on elevated ground with a porous soil. The larger the rooms the better, so situated as to be daily flooded with light. The patient's room should be warm, as far as possible kept between 54° and 60°, but well ventilated by windows constantly open, the bed being so placed that it is not between window and door, or window and fire, and therefore not in a draught, but yet perfectly open to the fresh air.

Climate.—In general the country is to be preferred to the town, inland to be preferred to the sea-coast, and a high level to be preferred to a low. But the high level should be open, not surrounded by hills, open moorland, for instance. A sea voyage of some duration is an exceedingly good aid to recovery in some cases of consumption. In selecting a climate for either a temporary or a lengthened stay, the things to take into account are the amount of sunshine, the dryness of the air, the freedom of the air from dust, the absence of great oscillations of temperature. Patients in early stages of consumption, who are able, and propose to go away for a prolonged period, should, in selecting a climate, consider whether the place they select might, if it suited them, be a place in which they could subsequently settle. Davos, for instance, among the Alps, may be very beneficial, but the descent from there is apt to be followed by a return of the disease. On the other hand, Denver, in Colorado, and many places in California afford plenty of opportunities for settling down in business if the place agrees.

Special Treatment.—The acute cases must be treated in bed, though, if the house and situation permit it, the bed may be outside, protected from wind and rain, the patient being thoroughly well covered up, head and neck as well as body, and the feet kept warm by a hot bottle. In such cases also the diet must be liquid, milk and soups, solids being gradually added as improvement takes place. The patient should not be permitted out of bed so long as fever exists to any noticeable amount.

Fever is best treated without drugs by tepid sponging of arms and legs, or the whole body, repeated as often as necessary, the water being at a temperature of 75°, and from time to time lowered till water at 60° is used if the patient bears it.

Cough.—The treatment of cough will depend on its character; the irritable, dry cough being relieved by inhalations of steam, medicated with compound tincture of benzoin (a tea-spoonful to an inhalation) with eucalyptol, menthol, creasote, camphor, &c. Some form of opium may be necessary, but it should be avoided if at all possible. A codeia pastille should first be tried, or some one of the numerous pastilles now obtainable from druggists.

Sweating.—Sponging with vinegar in the water should first be tried, a tea-cupful of vinegar to a pint of water. If that fails, a pill of $\frac{1}{2}$ to 1 grain extract of belladonna, or $\frac{1}{100}$ grain of its active principle—atropine—may be tried.

Diarrhœa may be due to the irritating character of the bowel contents, if it is not dependent on ulceration already present. In either case the bowel will be soothed by each morning securing that it is swept clean of such matters. For this 1 tea-spoonful of castor-oil, with or without 5 drops of laudanum, may be effectual for a long time, provided the diet is carefully regulated. If this does not suffice, the usual remedies for diarrhœa (p. 242), beginning with bismuth, may be tried.

Pain in the chest may require poultices, blisters, or sedative drugs, but which of these will depend on the condition of the patient.

Bleeding.—The treatment is noted on p. 370. The hypodermic injection of $\frac{1}{100}$th grain of atropine, with or without a small dose, $\frac{1}{8}$th grain, morphia, acts with great rapidity, and often with remarkable success.

THE DRUG TREATMENT OF CONSUMPTION.

Antiseptic Treatment.—Consumption being an infection it is natural to seek for some remedy which will destroy the organism in the tissues of the lung. To do this without injury to the patient is the difficulty. It is attempted in the main in two ways, first by medicines given by the mouth, and second by inhalations or sprays, or direct injection into the air-passages. Mercury, iodine, iodoform, chinosol, carbolic acid, arsenic, have all been administered, and many others, for this purpose. The remedy, however, that has proved most useful is beechwood creasote. It may be given in capsule, each containing 1 minim, the number taken being gradually increased from 1 after each meal till 12 or 20 are taken daily, as the stomach bears them. It is given easily in oil, cod-liver oil by preference, 5 drops to each tea-spoonful, and large doses may be borne in this way. Guaiacol, a derivative of creasote, is better borne by the stomach. It is a tasteless powder, may be taken in milk, 3 to 8 grains, four, increased to six, times a day. The use of inhalations, sprays, atomizers, &c., is fully discussed on p. 416, Vol. II.

The use of lime preparations and cod-liver oil is considered on pp. 410, 411, Vol. II.

Tuberculin.—Koch, the discoverer of the tubercle bacillus, announced, in 1890, the discovery of a method of curing the disease by inoculation. The idea involved in inoculation is easy to understand, as soon as consumption is admitted to be an infection. Few persons take the same infectious disease a second time. This is due to the fact that the disease has produced some change in the blood or tissues that hinders them from being suitable for further growth of the organism of the disease. Probably this result is due to products of the organism. The organism, that is to say, by its own growth in blood or tissues, produces substances inimical to its own continuance, and so its further growth is cut short. Koch, therefore, grew tubercle in pure culture, and made an extract of this, the organisms themselves being removed. This extract was called tuberculin. Koch believed that this substance, injected into a person in the early stage of the disease, arrested the further development of it, and cured the disease, while advanced cases, though not cured, were benefited by it. The continued use of the substances has not yielded the anticipated benefits.

One noteworthy result, however, was obtained. The injection of tuberculin into perfectly healthy persons produces little or no result. But if the person has tubercle anywhere in the body, the injection is followed by fever, pain in the limbs, and great general disturbance. This reaction lasts twelve to fifteen hours, beginning a few hours after the injection. The injection undoubtedly causes changes in any tubercular tissue in the body, hence the reaction, but it has not been found to lead to cure. Tuberculin, however, may be used as a test for the presence of tubercle, and in a doubtful case its use will aid in determining the true nature of the affection. This is of limited utility in man. In cattle the same effects are produced, so that tuberculin has become increasingly useful to detect the presence of tubercular disease in cattle.

Behring's "Cure".—Considerable sensation was occasioned at the "International Congress on Tuberculosis", held in Paris in 1905, by the announcement made by Prof. E. von Behring, of Marburg, that he believed he had discovered a method of producing immunity towards tubercle. It was Behring who discovered the method of treating diphtheria by the injection of antitoxin (see p. 539). The true nature of the curative principle is not yet to be announced. So far its application has been only in the laboratory, and to animals; and it will be yet a long time before its value for man can be determined.

THE SANATORIUM TREATMENT OF CONSUMPTION.

Within quite recent years special institutions, at first only for paying patients, later for the poor also, have been opened for the treatment of consumption. These institutions are usually built, not, like most hospitals, in the centre of great populations, and where the people live who need the treatment, but away from populous places, in the healthiest obtainable situations. The patients, that is to say, must forsake business and home and their usual surroundings, and resort to such a place chosen for its salubrity. Hence the term "Sanatorium" has been employed. In these sanatoria the patients are, during the whole time of residence, and in every detail, under the full control of the medical man who is the chief authority in the establishment. The whole manner of life is regulated, from morning to night—what and when the patient shall eat or drink, how he shall be clothed, how much, if any, walking he shall do, how long he shall spend in bed, whether he shall be allowed to engage in conversation, and so on; all is regulated by the physician. Now this is nothing new in the case of the person who is acutely ill, or who is confined to bed. But up to recently the ordinary consumptive went about his business as long as he could, taking certainly what medicine he was ordered, and as much change to the country, or by a sea voyage, as was possible to him. So he went on till, in course of time, increasing exhaustion, hæmorrhage, or one of the multitudinous possible complications laid him by the heels, and he became, by inevitable necessity, restricted to his room or his bed, in preparation for his still narrower abode. But it is something new that the person threatened with consumption should give up for the time his business—unless, like a writer of books, he can take it with him—leave home, repair to some place where every condition of health is fulfilled, and place himself wholly in the hands of a physician who shall regulate, without thought of demur on his part, every minute of his day, while he is yet only threatened, and is able to go about quite freely, and his strength is yet comparatively little impaired. It is this that is the new thing, and not the principles of treatment. The new thing, in short, is the attitude of the public towards the disease. And this new attitude is, in turn, due to the fact that it has dawned upon the public mind that the disease—consumption—is curable. So long as the public believed it to be incurable, in spite of all the doctors said, so long did they resign themselves to the inevitable, and sought only to carry on their work and to refuse to believe that they were seriously ill. But the idea of curability having penetrated the public mind, attempted self-deception is given up, and the public is becoming willing in yearly increasing numbers to fulfil the conditions of cure, however arduous or sacrificing they may be, and patients are presenting themselves at such institutions, willing to surrender themselves, for six, nine, twelve months or longer, completely to the control of medical authority, in the hope of thereby eradicating the disease.

Now while this idea, that consumption is curable, is new to the public mind, it is not a new thing in medicine. Paradoxically enough it was the *post-mortem* table which afforded the conclusive evidence of cure. Over and over again hospital pathologists had observed and recorded, in the cases of patients who had died from causes wholly unconnected with the lungs, that many showed evidences, quite conclusive, of past disease of the lungs, such as scars of healed tubercular ulcers, cavities, and so forth. Further, it was recognized, even by the ancient physicians, that residence in elevated situations, purity of air, and abundance of good living were the essential things in the treatment of consumption. But it was not till 1854 that a complete demonstration was given of the fact that success was not to be looked for unless these rational principles of treatment were persistently and methodically carried out under strict trained supervision. This demonstration was given by a German physician, Dr. Hermann Brehmer, who in 1859 founded the earliest private sanatorium at Goerbersdorf in Silesia, near the Bohemian frontier.

It is not necessary to enter into any great detail as to sanatorium treatment, its broad principles are easily understood.

The sanatorium is situated, as a rule, amongst hills, in a district free from tubercular disease, where the air is pure and void of dust as well as of organic impurity, therefore remote from smoke, from factories, from railways, from highways, from large towns. The elevation should vary from 1500 to 3000 or 4000 feet, the air should be dry and crisp, the soil dry and well-drained. The building should have a southern exposure. It should be sheltered by hills from the wind while lying open to the south, and it should be so placed in relation to the hills that surround it that, while sheltered by them, it does not receive their drainage. The climate should permit the patient to spend most of his time in the open air. For this purpose the more extensive the private grounds of the sanatorium the better. In the best sanatoria an open verandah extends along the ground floor of the front of the building, so that patients may sit, or lie out, sheltered in all weathers, while in many the grounds are dotted with miniature chalets of single or double apartments, which rest on pivots so that they may always be turned to the sun. As to internal arrangements, the aim is to have the patients' rooms as large as possible, light and sunny, flushed with fresh air, and so furnished and decorated as to keep as free of dust as possible, the rooms being so constructed that the bed may be in shelter though doors and windows be open. Corners, ledges, cornices, hangings, are undesirable, because affording lodgment for dust.

A very important point in a well-constructed building is the deafening of the walls, so that the house is quiet, and one patient is not disturbed by another.

The whole life of the patient is regulated by the superintending physician, not in a merely general way, but in

> every detail, so that from day to day, one might say from hour to hour, each individual has laid down for him the circumstances most suitable for his condition.

In sanatorium treatment two things assume the very greatest importance:

I. Fresh Air; II. Feeding.

The Open-Air Treatment.—By judicious management the patient is trained to bear open-air life in all weathers, the skin being in various simple ways, by water douching among others, toned up and braced. But it must be observed that the size and shape of the patients' rooms, the position of the bed, and a host of other simple but important precautions, not to speak of the constant medical supervision and control, enable this to be done quickly and safely. The patient at home, who, on his or her own initiative, and without precaution or preparation, thinks to imitate sanatorium treatment by throwing wide windows and doors, and sitting and sleeping in a draught, is behaving only like a fool and ignorant person. But such persons are numerous.

The Diet Treatment.—The patient is in a similar way gradually accustomed to taking large quantities of food, the quantity being gradually increased small frequent meals being preferable to infrequent large ones. In this respect the medical control becomes of inestimable value. The precarious fickle appetite, instead of being humoured and yielded to, is gradually overcome by the moral control of the physician, and in a short time an amount of food is eaten and digested and made use of that the patients' friends deem impossible and incredible. The improvement in the general nutrition is immediate, and the effect on the progress of the disease very marked. The following is the arrangement of meals in most sanatoria:—

7 to 8 a.m. Glass of milk, and coffee, cocoa, or tea; white or brown bread and butter.
10 a.m. One or two glasses of milk with bread and butter, or soup and bread, or egg; perhaps a glass of wine.
1 p.m. Dinner: soup, two meat courses with vegetables, pudding; perhaps a little wine.
4 p.m. Afternoon tea, akin to early breakfast.
7 p.m. Supper of one or two courses, one hot one cold, with vegetables; perhaps a glass of wine.
9 p.m. Glass of milk with two or three tea-spoonfuls of cognac.

Of course the diet varies in different sanatoria, according to the custom of the country. It must also be adjusted to each individual, and be cooked in the best possible way, not only from the point of view of digestion but also from the point of view of its appetizing quality. Milk bulks largely in it; and at the beginning of treatment, in cases attended by fever, may be the exclusive diet. Four or five glasses a day should be regularly taken by the patient able to take full meals.

It is not necessary to enter into other details as to the treatment in sanatoria. It is sufficient to say that, for each patient, each day the amount of rest or exercise is laid down, and that, as the patient improves, his exercise is gradually increased, by graduated mountain-climbing and in other ways, till he becomes fit to return to his home.

It is also needless to emphasize the fact that in a properly-equipped institution every contrivance and arrangement exist to prevent contamination by the organisms of the disease. Promiscuous spitting is rigorously put down. Each patient must carry a specially-constructed flask for spitting into,[1] and these are regularly disinfected. There is probably, therefore, less risk of infection in a properly-managed sanatorium than in most places of public resort.

There are now many sanatoria in Germany, Austria, France, America, and the British Isles. The general tendency of opinion at present is towards the view that success depends more on the situation and construction of the sanatorium, the general management of the institution, and the methodical and constant medical control and supervision of each individual case than on the climate. There are many suitable situations in the British Isles, and numerous Home Sanatoria are already established, or in course of construction, where the treatment may be carried out as successfully as in the foreign establishments. The treatment is thus being brought within the reach of very many to whom a long journey to a foreign sanatorium would be an insuperable obstacle.

A list of the chief institutions at home and on the continent of Europe follows.

Too much must not be expected of sanatorium treatment. A sanatorium is not to be regarded as a last resort, as a place to be kept in view "if things come to the worst." It is to be the place of first resort, if success is to be looked for.

In spite of the success of sanatorium treatment, it may yet be said with perfect truth that there are cases of advanced consumption beyond the power of any treatment to arrest. Indeed many sanatoria authorities recognize this and refuse to accept such cases, or admit them only for a short time, and if no distinct improvement occurs within a few weeks, send them away. Thus statistics published regarding 5032 patients treated at Goerbersdorf showed that of 1390 patients in the first stage of the disease nearly 59 per cent were cured or nearly cured, while of 2225 in the second stage only 21½ per cent were cured or nearly so, while of 1517 in the third stage only 3 per cent derived benefit. Again, the statistics published from time to time regarding Falkenstein, where advanced cases are not taken, show the number cured or nearly so do not exceed 30 per cent. These are absolutely reliable facts. Yet injudicious people, who happen to belong to the happy band of the cured, have written to the lay press in terms suggesting that an absolute cure is in all cases obtainable. Such an expectation could be encouraged only by those who are so ignorant of the true character and varieties of the disease as to assume that, because they have been cured, every other case may be also, provided of course they go through an identical course of treatment. Such an expectation is not to be encouraged. The lesson of the statistics is that "delay is dangerous," and that the sooner a patient suffering from consumption repairs to a sanatorium the more hopeful may he be of success, and the longer he delays the smaller becomes his chance.

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[1] Dettweiler's flask is one of the best.

Nordrach in the Black Forest has been so much written about that many people are under the impression it, and not Goerbersdorf, is the birthplace of the sanatorium treatment, whereas the Sanatorium at Nordrach was not established for over thirty years after Brehmer had demonstrated the success of his methods at Goerbersdorf. It then consisted of a single house with accommodation for ten patients. Yet the treatment is often called "the Nordrach treatment." The place is 30 miles from Strassburg, and may be reached by carriage from the stations Biberach-Zell or Gengenbach on the Black Forest railway. The Sanatorium stands within about eighty acres of its own grounds, and is surrounded by miles of forest land. Dr. Walther follows out the system with great steadfastness. The rooms are furnished with severe simplicity; there are no carpets or hangings; there are no amusements for the inmates collectively; visits of friends and relatives are discouraged; all business is forbidden, except the business of cure.

Patients are compelled to go out at all hours and in all weathers, extra wraps being provided when necessary, unless their condition requires the only other alternative, rest in their own room in bed, the windows being open. Many of the windows are made to be taken out altogether during the warmer part of the year.

Just as the fresh-air system is pursued to its utmost limit, so the other element in the treatment—feeding—is pushed vigorously, and even forced. "Several inaccurate accounts", says Dr. F. R. Walters, "have been given concerning the diet at Nordrach, even by presumably trustworthy observers, and Dr. Walther was at some pains to correct these inaccuracies. Three meals a day are provided, at 8.30 a.m., at 1 and 7 p.m. The breakfast consists of coffee, bread and butter, and cold meat of some kind. Dinner includes two hot courses of meat, or fish and meat, with plenty of potatoes and green vegetables, and sauces containing butter. Following this are pastry, farinaceous pudding, fruit or ice-cream, with coffee to finish. Supper consists of one hot and one cold course, together with tea. Milk is added to the dietary until the patient's weight has reached a reasonable standard, never more than a half-litre (less than a pint) being given with each meal. The meals are taken in the presence of the doctor, who encourages the patient to finish what is given him, and eat a reasonable quantity of every kind of food provided. The stories about patients being compelled, after vomiting, to begin their dinners over again against their will are inaccurate. So also are the statements as to enormous quantities of meat or food generally being given."

The same remark falls also to be made about Nordrach that has been made about all properly conducted sanatoria, that, namely, the medical supervision is constant, and extends to every detail of the patient's daily life.

No imitation of sanatorium methods can expect to be successful, except in the simplest cases, where this supervision is not properly and continuously exercised. Therefore in the selection of a sanatorium any patient should, at the very outset, enquire whether such detailed medical supervision exists.

Some of the institutions, named in the lists which follow, are of world-wide repute, and no mistake can be made in resorting to them. But concerning any of the less known, patients must make full enquiry for themselves.

BRITISH SANATORIA FOR CONSUMPTIVES

ENGLAND

County.	Name.	Situation.	Date of Foundation.	No. of Beds.	Elevation in Feet.	Rate per Week (Pre-War).
CUMBERLAND	Cumberland Sanatorium	Bleneathra	1904	20	870	Free, or 30*s.*
DURHAM	Belvne Sanatorium	Shotley Bridge	1899	20	490	3 to 5 guineas.
LANCASHIRE	Liverpool Sanatorium	Kingswood	1901	43	490	£1 to 3 guineas.
	Delamere Sanatorium	Birch Hill	..	90	420	......
NORTHUMBERLAND	Northumberland Sanat.[1]	Barrasford	..	50	650	......
WESTMORLAND	Westmorland Sanatorium	Meathop	1900	28	210	Free, and 2 guineas.
YORKSHIRE	Leeds Sanatorium[1]	Gateforth Hall	1901	32	70	Free.
MIDLAND COUNTIES	Notts Sanatorium[1]	Mansfield	1902	30	470	31*s.*; 10*s.*, or free.
	Midland Sanat., Bourne Castle	Belbroughton	1901	20	750	3 guineas.
	Worcestershire Sanat.[1]	Knightwick	1902	16	210	20*s.*, 30*s.*, or free.
ESSEX	Maldon Sanatorium	Maldon	..	12	..	2 to 2½ guineas.
NORFOLK	Mundesley Sanatorium	Mundesley	1899	31	200	5 guineas.
	The Firs	Mundesley	..	6	..	2½ to 3 guineas (for advanced cases).
	Kelling Sanatorium	Holt	1903	42	..	30*s.*, or free.
	The Beeches	Long Stratton	1901	7	120	2 to 3 guineas.
	The Manor House	Southrepps, near Mundesley	..	8	..	16*s.* to 25*s.* (women only).
SUFFOLK	East Anglian Sanatorium	Nayland	1900	35	260	4 to 6 guineas.
	East Anglian Sanatorium (for poorer classes)	,,	1904	27	200	£1 for women, £2, 2*s.* for men.
BERKSHIRE	London Open-air Sanat.	Wokingham	1901	64	220	3 guineas.
HAMPSHIRE	National Sanatorium	Bournemouth	1885	72	118	7*s.* 6*d.*
	Overton Hall	,,	1898	12	118	4 guineas.
	Stourfield Park Sanat.	Near ,,	..	40	..	4 guineas.
	Linford Sanatorium	Ringwood	1899	24	160	4 to 5 guineas.
	Moorcote	Eversley	1899	20	295	3 to 4 guineas.
ISLE OF WIGHT	Royal National Hospital for Consumptives	Ventnor	1869	156	79	10*s.*
JERSEY	The Pines	St. Brelade's	1904	8	Coast	7 guineas.
OXFORDSHIRE	Hailey Sanatorium	Ipsden	1900	30	250	3 guineas.
	Maitland Cottage Sanat.	Peppard	1901	16	375	25*s.*, 30*s.*, 8*s.* nomination.
	Subscription Sanatorium	Ipsden	..	14	..	32*s.* to 2 guineas.
SURREY	Crooksbury Sanatorium	Farnham	1900	24	410	4 to 5 guineas.
	Whitemead Hill Sanat.	Tilford	1899	20	303	4 to 5 guineas.
	Ockley Sanatorium	Ockley	1903	12	350	2½ guineas.
SUSSEX	King Edward's Sanat.	Midhurst	1907	100	495	88 free, 12 paying moderate fees.
	Rudgwick Sanatorium	Rudgwick	..	14	..	2½ guineas.
DEVON	Dartmoor Sanatorium	Chagford	1903	20	755	3 to 5 guineas.
	Devon and Cornwall San.[1]	Didworthy	1903	16	..	31*s.* 6*d.* and upwards, or free by nomination.
	Dunstone Park Sanatorium	Paignton	1900	10	550	2½ to 4 guineas.
DORSETSHIRE	Alderney Manor Sanat.	Parkstone	1900	28	210	4 guineas.
	Cotswold	Birdlip, near Stroud	1898	33	800	4 to 5 guineas.
	Painswick Sanatorium	Painswick	1900	12	600	2½ guineas.
SOMERSETSHIRE	Nordrach-upon-Mendip	Blagdon	1899	40	862	4 to 6 guineas.
	Mendip Hills Sanatorium	Mendip Hills	1900	24	852	3½ to 5 guineas.
	Luftkur Sanatorium	Portbury	1904	..	400	4 to 10 guineas.
WILTSHIRE	Royal Victoria Memorial Sanatorium	Winsley	1904	60	600	6*s.* and free.
DERBYSHIRE	Matlock Sanatorium	Matlock Station	1919	30	700	6 to 7 guineas per week.
		WALES				
NORTH WALES	Nordrach in Wales	Penmaenmawr	1900	23	..	5 guineas.
	Vale of Clwyd Sanatorium	Ruthin	1901	21	450	5 guineas.
		SCOTLAND				
NORTH OF FORTH	Grampian Sanatorium	Kingussie	1901	20	855	4 guineas.
	Sidlaw Sanatorium	Auchterhouse	1903	40	800	2 guineas.
	Nordrach-on-Dee	Banchory	1900	52	..	5 guineas.
	Knocksnaltach Sanat.	Kirkmichael	..	6	..	£1, 1*s.* to £3, 10*s.*
	Hillside Home Consumptives Hospital	Barnhill, Perth	1901	20	200	1½ to 2 guineas.
	Ochil Hills	Kinross	1902	60	800	4 to 6 guineas.
	Ellerslie Sanatorium	Crieff	..	8	490	3 to 3½ guineas.
	Tor-na-Dee	Deeside, Murtle	1918	60	..	6 guineas (post-War rate).
SOUTH OF FORTH	Ayrshire Sanatorium	Ashmark	..	..	412	For poor of Ayrshire.
	Royal Victoria Hospital for Consumptives	Craigleith, Edinburgh	1894	102	150	21*s.*, or free.
	Woodburn Sanatorium	Morningside, Edinburgh	1899	24	..	5 guineas.
	Caverhill Sanatorium	Near Peebles	1904	14	810	2½ guineas.
	Bellefield Sanatorium[1]	Near Lanark	1904	30	600	Free (Glasgow cases).
	Bridge-of-Weir Sanat.	Bridge of Weir, Renfrew	1898	80	260	£1, or free.
		IRELAND				
DOWN	Rostrevor Sanatorium	Rostrevor	1899	23	352	3½ guineas.
WICKLOW	Altadore Sanatorium	Kilpedder	1901	15	650	3½ to 5 guineas.

NOTES.—Costs per week include medical attendance, but not extras such as alcohol, bedroom fires, laundry.

[1] Established by, or with the assistance of, the local branch of the National Association for the Prevention of Consumption.

Any person desiring information concerning any of these institutions, or advice in dealing with any consumptive case, should address the secretary of this association at 20 Hanover Square, London, W.1.

FOREIGN SANATORIA FOR CONSUMPTIVES

In America a great deal is being done in various ways to cope with consumption, and there are a great variety of institutions following out, more or less efficiently, the system already described. But there are many "Homes," "Camps," &c., where consumptives live, spending most of their time in the open-air, yet scarcely comparable to the institutions modelled on the German lines. These are not noted in the list that follows, there being included here, as in the British list, only such institutions as exist mainly for the treatment of consumptives, on the regular lines we have described, and under the constant supervision of a qualified physician.

AMERICA

State.	Name.	Situation.	Date of Foundation.	No. of Beds.	Elevation in Feet.	Rate per Week (Pre-War).
COLORADO	Colorado Sanitarium	Boulder (Denver)	1893	200	5300	13 to 35 dollars.
CONNECTICUT	Pulmonary Sanitarium	New Canaan	1897	30	..	25 to 35 dollars.
MARYLAND	Endowood Sanitarium	Blue Ridges Mountains	..	..	490	Poor free; private rooms 5 to 10 dols.
MASSACHUSETTS	Mass. State Sanitarium	Rutland (Boston)	1898	250	..	3½ dollars.
NEW MEXICO	Las Vegas Sanitarium	Las Vegas	1897	350	6750	16 dollars, up.
NEW YORK	Adirondack Cottage Sanit.[1]	Saranac Lake	..	100	..	5 dollars; a few free.
	Gabriels Sanitarium	Gabriels	..	100	..	Poor are received at suitable fees.
	Loomis Sanitarium	Liberty	..	100	..	10 to 15 dollars.
	Montefiore Home Country Sanitarium[2]	Bedford	1897	160	..	Free.
	Pasteur Sanitarium	Suffern	..	..	..	12 to 25 dollars.
	New York State Sanitarium	Ragbrook	..	200	..	......
	De Peyster Hospital for Children	Verbank	..	40	1100	2½ dollars.
NORTH CAROLINA	Winyah Sanitarium	Asheville	1878	70	2250	30 dollars, up.
	Asheville Sanitarium	Asheville	..	75	2350	Full price.
PENNSYLVANIA	White Haven Sanitarium	White Haven	1902	125	..	State aided.
SOUTH CAROLINA	Aiken Cottage Sanitarium	Aiken	..	15	..	......
TEXAS	White Gables Sanitarium	Boerne	..	25	1430	25 to 90 dollars.
VERMONT	Champlain Sanitarium	South Hero	..	18	5270	......
CALIFORNIA	Idylwild Sanitarium	Hemet	1905	..	..	15 to 50 dollars.
	Pottenger Sanitarium	Monrovia	1905	..	1000	30 to 50 dollars.
	Ballard Sanitarium	Pasadena	1905	..	990	25 dollars.
NEW HAMPSHIRE	Pembroke Sanitarium	Concord	1905	..	5930	15 dollars.

CONTINENT OF EUROPE

Name.	Situation.	Date of Foundation.	No. of Beds.	Elevation in Feet.	Rate per Week (Pre-War).
GERMAN:					
Dr. Brehmer's[3]	Goerbersdorf, Silesia	1859	156	1840	£3 to £7.
Dr. Brehmer's, 2nd Class	Do. do.	1894	153	1840	£2 to £3.
Römpler's	Do. do.	1875	100	1805	£3 to £5.
Weicker's	Schmidtsdorf, 1 mile W. of Goerbersdorf	1893	30	1837	From £2, 15*s*.
Dr. Driver's	Reiboldsgrün, in the Erzgebirge, Saxony	1873	108	2296	£2, 15*s*. to £4.
Dr. Michaelis'	Rehburg, Hanover	1886	20	300	£3 to £4.
Falkenstein[3]	In the Tannus Mounts, near Frankfort-on-Main	1876	112	1312	£4 to £7.
Hohenhonnef[3]	Near Koenigswinter, on Rhine	1892	109	774	£4 to £6.
Laubbach	Near Coblenz	About 1897	113	262	£3, 10*s*. to £5.
Laubbach, 2nd Class	Do. do.	....	..	262	About £2, 10*s*.
Nordrach	Black Forest	1888	45	1470	£3, 10*s*.
Schömberg	Do. near Wildbad	1890	50	2130	£3, 3*s*. to £4, 4*s*.
St. Blasien	Do. (Baden)	1878	60	2700	£3, 10*s*. to £5.
Waldhof-Eigershausen, 1st Div.	Prussia	1900	26	1230	£2, 2*s*. to £3, 3*s*.
2nd ,,	Do.	1900	28	1230	22*s*. to 28*s*.
3rd ,,	Do.	1900	62	1230	28*s*. to 31*s*.
Reichelsheim	Hesse	1901	..	..	Women only.
St. Andreasberg	Hanover	....	17	..	.....
Reiboldsgrün	Saxony	1873	150	2300	35*s*. to 55*s*.
SWISS:					
Arosa	Upper Engadine, 6 miles from Chur	1887	65	6090	£3 and upwards.
Dr. Turban's	Davos Platz	1887	80	5160	£4 to £5.
Dr. Philippi's	Do. do.	1897	40	over 5000	£3, 3*s*. to £5, 5*s*.
Leysin	Canton de Vaud	1892	110	4150	£4, 4*s*. and upwards.
Palace Hotel Sanatorium	Montana-sur-Sierre, Canton Valais	1919	110	5050	26½ to 55 francs per day (post-War rate)
FRENCH:					
Canigou	Pyrénées Orientales, near Vernet-les-Bains	1890	100	2200	£4 and upwards.
Durtol	Puy-de-Dôme, near Clermont Ferrand	1898	32	1706	£5 and upwards.
Trespoey	Basses Pyrénées, near Pau	1896	14	696	£5 to £7.
Mont Bonmorin	Puy-de-Dôme, near Ardes	1897	120	2630	?
Mont-des-Oiseaux	Var	1902	160	..	....
ITALIAN:					
Gries Sanatorium	Botzen, South Tyrol	1901	..	..	....
St. Pancratius Sanatorium	South Tyrol	1902	49	300	....
BELGIAN:					
Boekrych Sanatorium	Boekrych, Limburg	....	60	..	From 7 francs per day.

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[1] Specially for working men and women.

[2] Intended chiefly for the poor.

[3] Specially commended.

In Falkenstein special attention is given to throat complications.

THE PREVENTION OF CONSUMPTION.

Incidentally all that is necessary has been said on this part of the subject. The precautions to prevent the spread of the disease by infection from dried spit, or from meat or milk, have been referred to. The value of sunshine and fresh air as disinfectants has been mentioned. Further, the ordinary precautions adopted in every other infectious disease should be regularly in use in tubercular cases. The room used by a consumptive should be periodically disinfected, and, in the event of death occurring, specially thorough disinfection should be practised.

It should not be forgotten that for those who are delicate and suspected of a consumptive tendency much may be done to ward off the disease. It ought never to be taken for granted that a person is bound to be a victim of consumption either because of the state of health of the individual or because of the family tendency. On the contrary, many persons have been saved from such a fate by such attention and care as have been recommended in the early paragraphs on treatment, who otherwise would have had little chance of escape. Such measures as have been urged ought to be rigidly carried out. *Ordinary colds ought never to be neglected*, and if cough, &c., threaten to remain, change of air should be tried without delay. Mothers who, because of family tendencies, fear for their children are apt, in their anxiety, to do the very things that are most hurtful. They smother them up with clothes, and so hamper them in this way that all their healthy movements are restricted, those of the respiratory organs among the number. They keep them confined to hot rooms, and restrict their out-of-door exercise, and when the children are allowed out they are cumbered with so many wraps that walking is a labour; the children become hot and covered with perspiration, and wish to sit down on every odd door-step or other equally cold resting-place. Such measures as these are the grossest possible mistake, for, instead of warding off the threatened danger, they directly invite it.

> Abundance of fresh air is an essential in the prevention of consumption, and regular systematic exercise of the body, particularly of the chest muscles, is another.

The child who is confined to warm rooms or kitchen, and whose bodily temperature is artificially maintained instead of by its own activity, is unable to resist the influence of the slightest breeze. It is a hot-house plant that will be speedily blighted when brought into the open air. But it was made for the open air and not for the hot-house, and it is the ignorance or stupidity (let the proper terms be applied, though they are strong) of mother, nurse, or guardian that has overturned the design of nature, and substituted sickliness and weakness for health and vigour.

There is, however, the other extreme, equally at variance with sense and fact as the former, the extreme of which parents and guardians are guilty who adopt what is called "the hardening process." They expose their children to all sorts of weather improperly protected; they treat them to daily cold shower-baths as a matter of routine, and so on, in the expectation that they will become used to and unaffected by exposure. The only proper course is for children to be clothed so that no healthy movement is restricted, and so that a regular and moderate degree of warmth is maintained. Plenty of exercise in the open air should be allowed; but excessive exercise, that throws the child into perspiration and leads it to sit down to cool, is to be cautioned against. In warm weather the clothing should be lighter to counterbalance it, and in colder weather heavier, both extremes being avoided in which the child is either never warm unless romping or always so warm as never to be able to romp.

The preventive treatment for adults is such as has already been described under general treatment.

Young adults, in particular, who have any reason to fear the possibility of this disease, cannot give the subject too serious a place in any consideration as to the kind of life they should lead or the nature of the work they should select. Any occupation involving irregular hours, close confinement in ill-lighted, ill-ventilated, or crowded premises, engaging in work which, from its nature, impregnates the atmosphere with dust particles, or particles of fluff, or such like, should all be avoided.

Work should be sought in the country or the small country town rather than in a large manufacturing centre, even at a sacrifice of ambition or wages, at least till a vigorous maturity is assured. Wherever possible recreation should be found in the open air and in open-air games, rather than in indoor amusements.

SPECIAL SYMPTOMS CONNECTED WITH THE LUNGS AND AIR-TUBES.

Cough is a symptom of many different affections, and its treatment depends on its cause. It consists of a deep breath followed by closure of the glottis, and a series of rapid expiratory efforts. It is the result of a nervous action originating in an irritation of the ends of sensory nerves distributed to the inner surface of the larynx. The impression is conveyed to the centre for breathing in the medulla (p. 150), and from thence impulses pass to the muscles of respiration and to those of the glottis, by which the cough is produced.

The irritation which begins the process may be owing merely to cold air entering the larynx and passing over an inflamed surface. It may be that the surface is not inflamed, but that the indrawn air contains irritating particles.

Again, it may be caused by the tickling of some phlegm poured out by an inflamed membrane, or of some matter swept up from the lungs.

It may also be a mere nervous affection, or due to some condition of the blood, as in gout and rheumatism, or the nervous irritation may arise from disordered stomach or liver.

The cough is thus either dry, that is, unaccompanied by spit, or moist when it is so accompanied. It varies in character. It is spasmodic in whooping-cough and croup. The "whoop" which attends the former readily distinguishes it, and the loud brassy sound of the latter is characteristic. In cough from obstruction of the air-passages arising, for example, from an inflamed and swollen lining membrane, such as common cold produces, it is also spasmodic and wheezy. Where the vocal cords are rough, owing to swelling, it is harsh, barking, and hoarse, and when the cords are covered with membrane, as in diphtheria, it is wheezy and voiceless.

The treatment depends so entirely on the cause that it is impossible to give any special treatment for the mere symptom. It may be noted, however, that one of the commonest and most troublesome coughs attends slight cold from swelling and irritability about the larynx. Warm poultices over the front of the neck greatly soothe and relieve it. If that fail, a piece of flannel sprinkled with turpentine, or with soap and opium liniment, should be placed directly over the larynx on the neck. If a mustard poultice be used, and it is often very efficient, it should be placed lower down at the top of the breast-bone. A cough due to an inflamed larynx is usually dry, and if obstinate, great pain is experienced in a line across the front of the chest, the line of the diaphragm (p. 345), occasioned by the severe and constant spasmodic movement of the chief muscle of breathing. Other means failing, a dose of 10 to 15 drops of laudanum (*only to adults*) will stop it more or less for a time. This, however, would be the worst possible thing to give were the cough attended with much spit, as in bronchitis, inflammation of the lung, &c. It is the matter coming up from the lung that is the irritating agent in such cases. Laudanum and other similar soothing drugs would simply blunt the nerves to the presence of the matter, which would not be expelled, but be allowed to remain in the tubes, and might by blocking them seriously aggravate the state of the patient. In such cases what is desired is to aid in the expulsion of the matter without serious efforts of coughing. For this purpose warm applications to chest and throat are valuable, and drugs like ipecacuanha wine (5 to 10 drops) and syrup of squills.

A very intractable form of cough is produced by relaxed throat and elongated uvula. The long uvula touches the tongue and maintains a constant tickling. The sprays recommended for clergyman's sore throat (p. 390) are useful here. The best treatment, however, is to snip off a piece of the too-long uvula with scissors, which occasionally causes the cough to stop as if by magic.

Difficulty of Breathing (*Dyspnœa*, Greek, *dus*, difficulty, and *pneo*, to breathe).—Difficulty of breathing attends many affections of respiratory organs, and occurs in very varied degree. It may amount to mere increased rapidity of breathing and shortness of breath on the slightest exertion, owing to general feebleness, as in anæmia, or to disease of the heart, or chronic disease of the lung, and may produce little discomfort. More than this it may be, up to that degree in which breathing is a constant struggle, agonizing almost in its character, when every muscle that can possibly aid in drawing air into the lungs is called into play, nostrils working, muscles of neck straining, and chest heaving, the lower part being frequently sucked in. In children the movement of the nostrils is often the first indication of some interference with easy breathing, and later excessive heaving of the belly and sucking in of the lower ribs become marked. Accompanying the severe forms of dyspnœa are indications of the want of proper aëration of the blood, lividity of the surface of the body, blueness of finger nails, coldness of the extremities; and when the struggle is severe the perspiration stands in beads or streams down the face. When the difficulty is considerable and lasting, without being so extreme, the want of proper purification of the blood produces headache, languor, and dulness. In asthma (p. 366) the difficulty of breathing comes on in spasms, is often excessively severe, seeming to threaten suffocation, and gradually passes off after a time.

Dyspnœa is of various kinds. Sometimes it is due to obstruction in the air-passages because of swelling, the formation of false membranes, dropsy of the larynx (p. 363), the presence of foreign bodies or tumours, or accumulation of secretion, as in bronchitis, or blocking of the lungs, as in pneumonia (p. 368) and consumption, &c. It is a common symptom of valvular disease of the heart (p. 319). It may be of nervous origin, as in asthma; and it must not be forgotten that it may be associated with a cause quite outside of the chest, owing, for instance, to tumours or accumulated fluid in the belly pressing up the diaphragm (p. 345), and thus interfering with expansion of the chest. In this way an overloaded stomach, or a stomach distended with gas, or a dilated stomach, or a congested liver, will cause shortness of breath.

Suffocation (*Asphyxia*, Greek, *asphuxia*, a stopping of the pulse) is an advanced stage of dyspnœa. It is the result of want of oxygen in the blood. Usually this want is the result of the exchange between the gases of the blood and those of the external air (p. 349) being interfered with, so that not only does the deficiency of oxygen become marked, but there is an accumulation of carbonic acid gas in the blood. Excess of the latter gas in the blood would not, however, produce suffocation, provided sufficient oxygen were at the same time supplied; but it would produce the signs of narcotic poisoning, namely, profound sleep, and complete insensibility that might end in death. It is the lack of oxygen that produces the results to be described.

It is evident that asphyxia may be brought on in two ways: (1) either by the person being in an atmosphere incapable of supplying anything like the due amount of oxygen, or, (2) while the atmosphere is of a proper kind, some obstacle exists to the admission of the air to the blood. The latter event may happen because the air cannot be introduced to the lungs because of paralysis of the respiratory movements, because the lungs have become blocked up and cannot admit it, or because some obstruction exists in the air-passages. Thus some foreign body may have fallen into the windpipe, or the windpipe may be closed by strangulation, or the chest may be prevented moving, as, for instance, happens when a mass of earth falls upon a person, burying him up to the neck.

Asphyxia may occur suddenly by sudden complete interruption to the breathing, or may came on more slowly, as it does in some diseases, difficulty of breathing becoming worse and worse till it passes into a state of suffocation. However it occurs its symptoms are the same.

Symptoms.—Three stages are recognized in the progress of the process of suffocation. In the *first stage* there is great difficulty of breathing, in which every muscle is exerted in the effort to get air into the lungs, the veins of the surface of the body becoming distended and livid. This laboured breathing passes into general convulsions, in which nearly all the muscles of the body partake, the fæces and urine being passed by the convulsive movements.

Then follows the *second stage*, in which the animal or person lies quiet and insensible, the pupils being widely dilated, the muscles all relaxed, and no movement is capable of being called forth.

Following this is the *third and final stage*, when long and slow efforts to breathe in are made at long intervals, and become gradually like convulsive gasps, until with one final gasp, head being thrown back, back arched, nostrils dilated, and mouth widely open, death occurs. The heart ceases only after all other movements have stopped.

If the obstruction to the breathing be sudden and complete the stages are all passed through in the course of three to five minutes, and the heart stops in between seven and eight minutes after deprivation of air. In experiments performed to ascertain after what lapse of time recovery could occur, it was found that a dog, simply deprived of air for four minutes, recovered; but if deprived of air by submersion in water, recovery was impossible after one and a half minutes, apparently because the entrance of water had prevented the restoration of the lung's function.

Treatment of suffocation consists in removing, if possible, any obstacle to the entrance of air. If that has been accomplished the next thing is to cause air to enter the chest. When the case has not gone too far, movements of respiration may be excited by dashing cold water over the chest, or by lashing the chest with towels dipped in cold water. If no movements can be excited in this way air can still be caused to enter the lungs by artificial respiration (see ACCIDENTS AND EMERGENCIES). Sometimes breathing can be induced by electric shocks properly applied to the nerves of breathing. Recovery need not be despaired of unless the heart has ceased to beat.

Apnœa (Greek, *a*, not, and *pneo*, I breathe), cessation of breathing, is sometimes used to mean asphyxia. Really it means stoppage of breathing because of *excess* of oxygen in the blood, not because of deficiency. Let anyone take quickly a series of deep breaths. The desire for breathing will pass away for a little, and a slight interval will elapse before it returns. The first few breaths after the interval will be feeble and shallow. The condition of apnœa has been produced.

Lividity (*Cyanosis* (Greek, *kuanos*, blue), *Blue Disease*) is only a symptom, and indicates want of proper aëration of the blood. If the blood has not its due supply of oxygen it becomes of a dark hue, and still more dark if it contains an excess of carbonic acid gas (p. 295). In such circumstances the purplish blood will give a livid hue to the skin instead of the ruddy colour of health, and the livid colour is most quickly seen in the lips, tongue, and under the finger nails, though in marked cases the whole skin exhibits the dusky colour. Any disease of the lung interfering with the due interchange of gases (p. 349) tends to produce it. It is most marked in a defective condition of the heart, dating from birth, owing to which impure blood from the right side is permitted to pass directly to the left side without previously passing through the lungs. It is, of course, a conspicuous symptom of suffocation.

AFFECTIONS OF VOICE AND SPEECH.

The voice may be affected in various ways. It may be weakened, that is, its *force* diminished, by any disease which reduces the general strength, or the extent of the movements of the vocal cords may be voluntarily lessened because of the pain any vigorous movement would call forth. Its *pitch* is variously affected, not only by the condition of the cords themselves, but also by the state of the air-tubes above them. The cords may be thickened by swelling, the result of catarrh, or the mucous membrane may be relaxed, so that the usual rapidity of vibration or stretching of the cords cannot be produced, and the pitch will be lowered. But the larynx and throat may be similarly thickened and relaxed so as to be unable to resound to sounds of the same pitch as formerly. Singers and public speakers ought to observe that enlarged tonsils (p. 217) act in this way, and markedly lower the pitch of the singing voice, or cause a painful sense of straining when singing or speaking for any time. Some celebrated singers, who have had enlarged tonsils removed, found with delight that after the operation they were capable of taking notes fully half an octave higher than formerly. The *quality* of voice is also affected in various ways, the most marked alteration being when hoarseness or huskiness is produced.

Hoarseness is due to irregular and imperfect bringing together of the vocal cords, and is most frequently due to swelling of the mucous membrane of the cords, to thickening, and to excessive secretion of mucus in their neighbourhood, such as common cold will readily induce. Various other reasons may exist to account for it, such as inflammation, ulceration, contraction, &c., of the cords or in their immediate neighbourhood. Most obstinate hoarseness is produced by syphilitic thickening and ulceration, and by tubercular ulceration, such as often occurs in the progress of consumption. Paralysis of the cords, owing to pressure on the nerves supplying the muscles of voice, or other nervous disease, is also a cause.

Treatment, to be of value, must have regard to the condition of the cords and larynx, and the condition can only be properly ascertained by examination with the laryngoscope (p. 356). The hoarseness that comes on quickly with pain on any attempt to speak, as a result of ordinary cold, should be treated with soothing remedies, the inhalation of the steam of boiling water, warm poultices to the neck, &c. Later, when all pain has passed away, and only the hoarseness remains, the sprays recommended for clergyman's sore throat are useful.

Clergyman's Sore Throat (*Dysphonia clericorum*).—This is an affection to which not clergymen only, but teachers, lecturers, and all public speakers generally are liable. It consists of a chronic thickening of the mucous membrane of the throat and larynx. The membrane is thickened and relaxed, and pours out an excessive quantity of thickened mucus, which is brought away with difficulty. There is a feeling of great discomfort in the throat, especially after speaking. The person feels as if a veil had been drawn over his speaking apparatus, as if something were present which by coughing or hawking he could dislodge, and he dislodges it only to find it again collect. It is the mucus that gives this impression.

Treatment is difficult, since the most vital part of it would be absolute rest for some time, and that is generally impossible. The person should always try to avoid straining the voice, and specially if he is affected with the slightest cold, as loss of voice lasting for some days might thereby quickly arise. His general health should be maintained as well as possible by stomach, bowels, skin, and kidneys being kept in good order, and by the use of some tonic medicine such as quinine and iron, or phosphorus quinine and iron (p. 169) if necessary. For the throat local applications are needful. Weak alum or chlorate of potash gargles are useful (see PRESCRIPTIONS); but these never get down to the vocal cords. For the medicine to reach the cords it must be drawn in with the breath in the form of spray. To effect this atomizers or spray-producers (see INHALERS AND ATOMIZERS, Plate XLVII.) are employed, by which the liquid is dispersed in a cloud of small particles by a strong current of air. The point of the atomizer is held within a few inches of the mouth. The mouth is widely opened, the tongue being kept down as much as the person can, and when a full stream of spray is directed into the mouth the person draws a long deep breath and thereby introduces the material into the larynx and windpipe. Various drugs may be used, of various strengths, with the spray producer. In the appendix on PRESCRIPTIONS—GARGLES, &c., some are mentioned. A useful one consists of tincture of steel, 2 fluid drachms, glycerine, ½ ounce, rose water, 1½ ounce, and water to 4 ounces. This is put into the bottle of the atomizer full strength, or diluted with water if necessary. If required it may be made stronger by the addition of one or more drachms of the tincture of steel.

In very troublesome cases, however, nothing equals the direct application of some solution to the vocal cords and affected parts by means of a brush. This only an experienced and dexterous surgeon can accomplish properly.

Loss of Voice (*Aphonia*, Greek, *a*, not, and *phōnē*, the voice) sometimes is the result of severe cold; ulceration and other changes of the vocal cords cause it. Paralysis of the cords makes it complete, and the paralysis is not infrequently the result of the nerves of voice being involved in some growth, or pressed upon by a tumour, aneurism, &c. In women loss of voice without any structural changes is frequent, being due to hysteria or other nervous condition. Nervous women, plagued with uterine troubles, are subject to it, and the loss of voice is not permanent but temporary, relapses being common. Cases are on record where no word was spoken for months or years, hysteria only being the cause.

Treatment it is needless to specify particularly, considering the necessity of someone being consulted who can determine the exact cause. In loss of voice from cold, however, warm applications to the neck, a blister over the top of the breast-bone, inhalation of steam, &c., are useful.

The Care of the Voice deserves a word. Anyone who reads the description of the vocal apparatus on pp. 354, 355 will understand how exquisite are the adjustments of the various parts for even ordinary speaking, and how the slightest alteration in the proportions of parts by cold, swelling, &c., will seriously affect the whole instrument. It should, therefore, be evident that anything that overstrains the parts—too prolonged use of the voice, talking or singing in too high a key, screaming, &c.—must have a bad effect on the vocal instrument; and that such overstraining will be most easily accomplished when the person is fatigued, in indifferent health, ill-nourished, or when the parts are affected by cold, &c. Therefore, wherever possible, in such circumstances the voice should not be used at all. Most people become impatient at the excuse of those who can sing, when a slight cold is offered as a reason for refusing; but it ought not to be so. Singers ought also to pay attention to the condition of tonsils, as they, if enlarged, materially affect the pitch and quality of the voice.

Careful training in voice production is a matter of primary importance. The mode of production of the singing voice is quite different from the mode of producing the ordinary speaking voice. Women breathe by the movement of the upper ribs mainly, and if this natural method of breathing were adopted in the production of the singing voice, it would result in the giving out of a tone lacking fulness and staying quality. To produce a proper singing voice the chest must be expanded with air and then fixed. The abdominal muscles then come into play, and, the chest walls remaining fixed, the air is pressed out with the exact strength required. Perfect control and smoothness of the voice is thus obtained. In this the muscles of the mouth and throat play no part; their business being to modify the shape of mouth and throat to affect the quality of the tone when produced. This control of breathing is the first thing a singer should seek to obtain.

If a singer has any difficulty with the breath, a careful examination should be made to see whether there is any obstruction, such as enlarged tonsils, or a narrowing of the airway of the nostrils.

Stammering or Stuttering implies a sudden check, followed by a longer or shorter pause, during which the person makes sundry attempts to utter the word at which he was stopped. It occurs most commonly in the utterance of the consonantal sounds p, b, t, d, g, and k, though also with s, z, sh, m, n, v, y, w, f, and more rarely with vowel sounds. As a rule persons do not stammer when whispering or singing. It partakes of a nervous affection, the complex series of muscular movements involved in speech not being properly subordinated to one another.

It is a defect which shows itself between the age of four and five and puberty, and may come on as the result of illness, or owing to fright or excitement, and *sometimes by imitation.*

Its **treatment** consists of careful training. The stammerer must be taught to speak slowly and deliberately, to practise the sounds at which he stammers, and restrain all tendency to become excited when nearing the sound which presents difficulties. Practising reading aloud in the presence of someone who will check any departure from deliberateness of utterance is one of the best possible aids. The stammerer must also train himself to regulate his breathing.

INHALATION OF IRRITATING AND POISONOUS GASES.

In the Great War a wide experience of the effects of the inhalation of irritating and poisonous gases arose from their use by the Central Powers for the purposes of attack. This use began in April, 1915, by the liberation of clouds of chlorine gas from cylinders, but in a short time a great variety of such agents was used. Some disabled the defence only for a time, such as those which caused sneezing, running at the eyes and nose, and the gas called "mustard gas", which irritated and blistered the skin—no relation to mustard. Others produced coughing and vomiting, and such as bromine and chlorine were actually suffocating, and set up acute inflammatory affections of the air-passages. One of the most lethal was **phosgene**, a colourless gas with a penetrating odour.

The worst were those which produced suffocating effects, and caused destructive changes in the air-passages. The immediate effects were sometimes relieved by inhalations of warm watery vapour, and the hypodermic injection of atropine and morphia, and subsequent treatment as for acute bronchitis. Lethal gases like phosgene, which weakened the heart, were treated by hypodermic injections of camphor oil. But the real remedy proved to be a respirator, which completely covered in eyes, nose, and mouth, with a cylinder attached through which air was drawn into the mouth. This canister had various layers of porous gauze, wool, charcoal, and a mixture of lime, caustic soda, and permanganate made in a granular mixture, which neutralized the poisonous and irritating properties of the air as it passed through. The respirator ultimately produced for the British army was so effective that, if properly put on as soon as the alarm of a gas attack was given, the troops were completely protected from every kind of vapour.

SECTION XVIII.

THE KIDNEYS AND BLADDER.

THEIR STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Kidneys:
- *Their structure*—tubuli uriniferi—Malpighian bodies or glomeruli;
- *Their functions*—the formation of the urine;

The Urine:
- *Its physical characters*—colour, specific gravity, quantity, &c.;
- *Its chemical constitution*—urea and uric acid;
- *Unusual constituents*—albumin, sugar, bile, blood, chyle.

The Ureters and Bladder:
- *The Ureters;*
- *The Bladder*—its structure and functions—the mechanism of the expulsion of urine.
- *The Prostate Gland.*

In the previous section the method by which the blood is purified to the extent of being deprived of its excess of carbonic acid gas, through the agency of the lungs, is described. But carbonic acid gas is not the only waste substance derived by the blood from the tissues. There are others as important, the result of the decomposition in the body of nitrogenous or proteid (p. 191) substances. If they are allowed to remain in the body death is the result. To separate these nitrogenous waste substances there must be some special apparatus. That special apparatus is found in the kidneys and their attendant organs, urinary bladder, &c. They are, therefore, exclusively excretory organs—organs solely devoted to the purpose of separating from the blood substances to be expelled from the body.

The substances separated by the kidney are in a liquid form, the urine; and as the urine is formed slowly, after passing from the kidney it is collected in a reservoir—the bladder—until some quantity has accumulated, when it is discharged by a voluntary effort.

THE KIDNEYS.

Refer to Plates XXII., XXIII.

THE STRUCTURE OF THE KIDNEYS.

The kidneys are two in number, and are situated in the cavity of the belly, one on each side of the back-bone, between the eleventh rib and the crest of the haunch-bone. The liver is above the right kidney, the spleen (p. 201) above the left; while both lie close against the back wall of the belly, so that the intestinal canal is in front of them. The human kidney is about 4 inches long, 2 inches broad, and 1 inch thick, and weighs usually about 5½ ounces.

The shape of the human kidney is the same as that of a sheep, or rabbit, and is well known.

The connections of the kidney are shown in Fig. 157, which represents the outline of the belly, opened, the intestinal canal being removed. A kidney appears on each side of the back-bone, blood-vessels being connected with each, and from each a tube—the **ureter**—passes downwards to the bladder, situated in the cavity of the pelvis.

Reference should be made to Plates XXII., XXIII., where the location of the kidneys is shown as if projected on to the front and back wall of the body; and where also is shown the direction a coloured chalk line would take which represented, on the skin, the course of the ureters to the bladder.

If a kidney be cut open in the direction of its length an appearance exhibited in Fig. 158 is seen. The ureter (U) where it joins the kidney expands into a wide cavity (P), which is called the **pelvis of the kidney**. Into the pelvis conical processes of the fleshy substance of the kidney project. The processes are called pyramids, or the **pyramids of Malpighi**, after the anatomist who described them, and in the human kidney there are about twelve of them. The point of each pyramid is invested by a part

Plate XXII

THE TOPOGRAPHY OF THE KIDNEYS

Front View

This plate is meant to show the location of the **Kidneys**, right and left, (R.K. and L.K.) and the tube, **ureter** (Uret.), passing from each to the bladder, indicated at the bottom of the plate by a black curved outline.

The plate shows the **heart** (mottled red) and the vessels arising from it, as described on Plate XVI. It also shows in black outline the **gullet** (G.), the **stomach**, and its continuation as **duodenum**, described in Plate XII.

It indicates how the great trunk—**aorta**—arising from the heart, after curving down behind the heart, traverses the chest and enters the abdomen, the gullet entering in front of it.

The plate indicates how, in the abdomen, the aorta, after giving off numerous branches, of which those to the kidneys are shown, divides into two large trunks, just below and to the left of the **navel** (U.), the **iliac arteries** (Il.A.); each of which subsequently divides into two, of which one goes to each leg (see p. 307).

Running alongside of these main arterial trunks are the main venous trunks, which bring the blood back to the heart; that coming down to the heart in the chest is the **descending vena cava**, that passing up to the heart from the abdomen, and receiving the renal veins on its way, is the **ascending vena cava**. They are two distinct vessels which enter the heart, the one from above, the other from below.

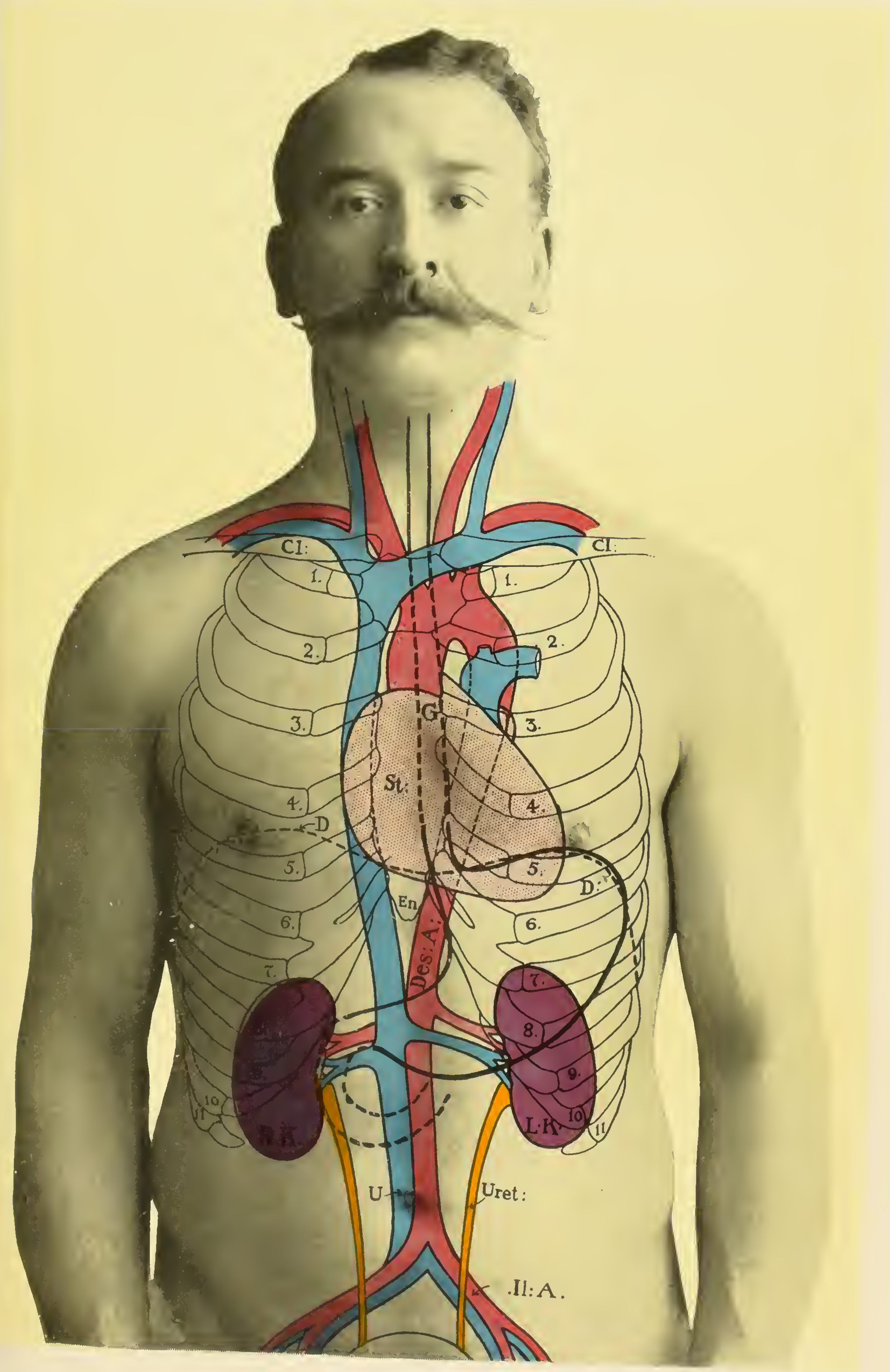
The plate shows that the right kidney lies a short distance from the middle line, and above the level of the **navel** (U.); as a matter of fact, the distances are about two inches from the middle line, and about one inch above the navel, the left kidney is slightly higher.

The plate indicates that on the front wall of the body the location of the kidney would be represented by curved lines extending from the 7th rib to the 11th on the right side, and on the left a rib higher. But it is to be noted that the ribs lie deep in the body, in contact with the back wall (see p. 392). Their position from behind is shown on Plate XXIII.

It is important to note how the ureter from each kidney passes on the outside of the blood-vessels at the level of the navel, and a little lower down crosses these vessels before entering the bladder.

A stone descending the ureter from the kidney might in any part of this line give rise to severe pain, and if this were on the right side and below the level of the navel, it might be mistaken for the pain of appendicitis (see p. 241).

PLATE XXII



THE TOPOGRAPHY OF THE KIDNEYS

(FRONT VIEW)

in continuation of the pelvis, which surrounds it like a cup or calyx.

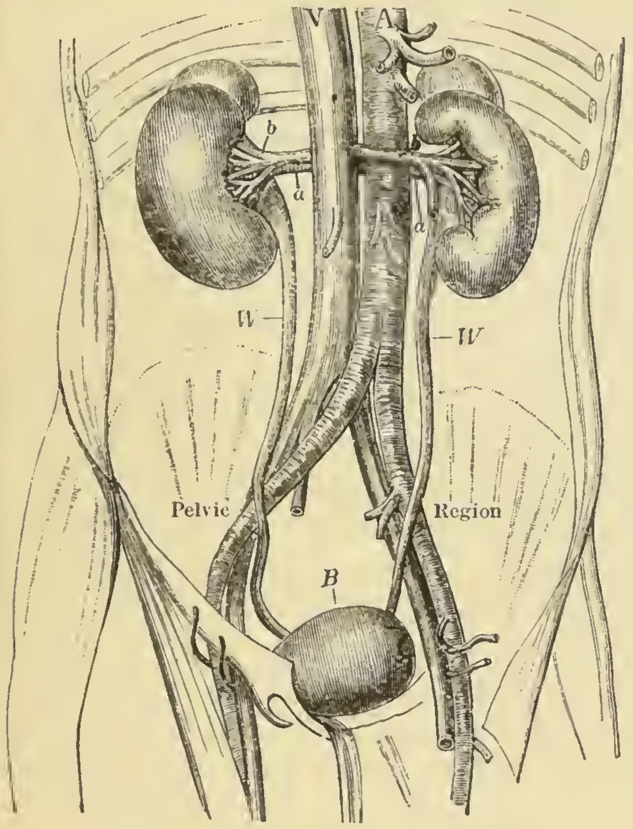


Fig. 157.—The Situation of the Kidneys.

A, Aorta; V, Vena Cava; B, Bladder; W, W, Ureters. Branches of the aorta (*a a*) are seen going to the kidney, and veins from it (*b b*) are shown joining the vena cava.

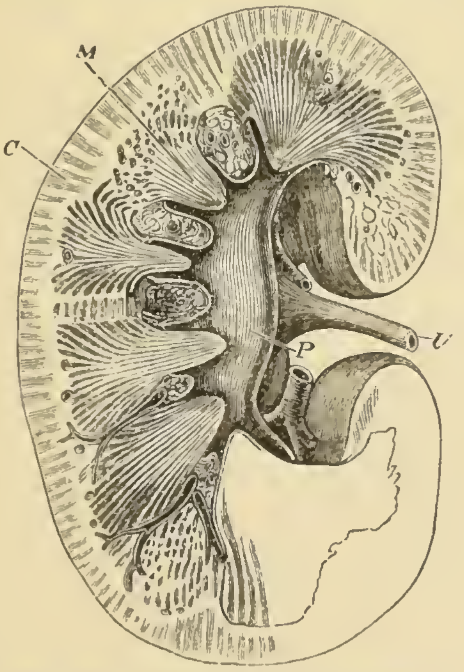


Fig. 158.—A Kidney opened in its length.

C, Cortical portion; M, Medullary portion; P, Pelvis; U, Ureter.

The urine-carrying tubes of the kidney.—The fleshy substance, of which the main mass of the kidney consists, and which towards the centre forms the conical projections referred to as pyramids, is made up of very fine tubes or tubules, the tubuli uriniferi, or urine-carrying tubules. Towards the surface of the kidney the tubules run a very irregular course, but towards the centre they run a straight course. The distinction between the part of the kidney containing the twisted tubes and that containing the straight tubes is easily made out with the naked eye, the former part appearing granular, and being called the **cortex** or rind, while the central parts appear streaked, and are called the **medulla**, or marrow. The distinction is represented in Fig. 158, where it is evident that the medullary portion is formed of the pyramids whose bases rest on the cortex.

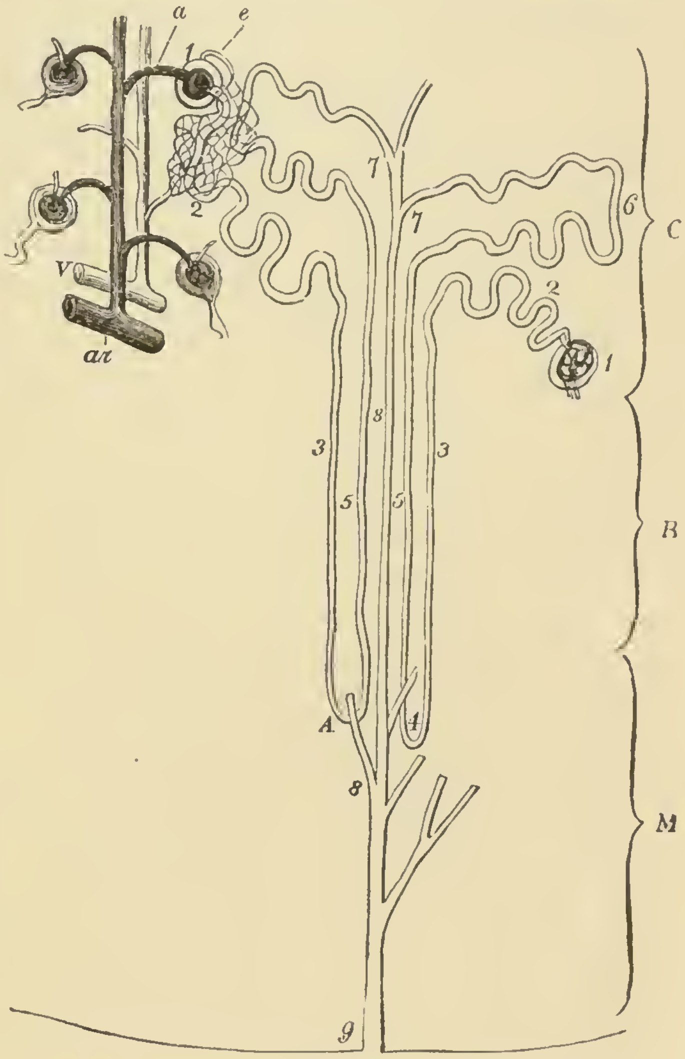


Fig. 159.—Representation of the Tubules and Blood-vessels of the Kidney.

On the right-hand side 1 points to the widened end of a tubule (in the cortex) containing a tuft of blood-vessels. The tubule passes off as the convoluted tubule (2), then it suddenly becomes straight (3) and passes down to the medullary region, turning back at 4 and passing back (5) to the cortex, where it becomes wavy (6), and ultimately joins a straight tubule 7, running downwards (8, 8) through the medulla to open at 9 on the point of a pyramid into the pelvis of the kidney (see Fig. 158). On the left-hand side of the figure the relation of tubule and vessels is shown: *ar* is a branch of the renal artery, from which a twig (*a*) passes off to enter the widened end of a tubule; *e* points to the vessel leaving the tubule and breaking into a mesh-work of capillaries, which finally form again into one vessel, joining a branch of the renal vein (V). The artery is shown giving off other twigs to other tubules. At the side, C indicates the cortical region, M, the medullary region, and B, the layer bounding the two.

It is in the tubules that the urine is formed. The tubules all ultimately open by a group of mouths on the surface of the pyramids, so that the urine formed in them finds its way into the pelvis of the kidney, and thence down the ureter into the bladder.

The **tubuli uriniferi**, of which the bulk of the substance of the tissue is made up, are very fine tubes, about the $\frac{1}{600}$th of an inch in diameter. They run a very irregular course, undergoing various changes in different stages. They begin in the cortical or outer portion of the kidney in a blind extremity which is widened into a pouch or capsule. Into the capsule, as will be noted hereafter, a bundle of capillary blood-vessels projects. From this expanded extremity the tubule passes off by a narrow neck, and winds a very irregular course in the cortex, twisting and turning upon itself for some distance. This part of the tubule is called the **convoluted tubule.** Then, after a short portion in which the tube is more spiral than twisted, it suddenly contracts to a very narrow diameter and courses straight on towards the central or medullary part of the kidney, into which it enters. But shortly after entering the medullary region it turns upon itself and proceeds, still in a more or less straight direction, and as a very narrow tube, back into the cortex. This narrower portion that doubles on itself is called the **looped tubule** of Henle, after the observer who first described it. Ultimately the tubule mingles again with the convoluted tubules, and again becomes itself wider and wavy or spiral. This second spiral part of the tube leads into a wider straight tube which passes down through the cortex to the medulla. As it proceeds through the medulla it joins, now and again, similar tubes at acute angles, or is joined by them, becoming thereby gradually wider until it opens on the surface of a pyramid. Fig. 159 gives a view of the passage of a tubule from its expanded extremity in the cortex to its mouth on the point of a pyramid.

In the different parts of their course different diameters of the tubule have been noticed, and there are other corresponding differences. The tubules are formed of a delicate membrane whose inner surface is lined with cells. In some parts of the tube the cells are large and cloudy, presenting the appearance of cells engaged in the active work of secretion. In other parts they are small and insignificant, evidently not for secreting purposes, but simply to act as a lining to the tube. Fig. 160 shows the appearance of a cross section of a part of a convoluted tubule and of a part of such a tubule opened up, the cells being large and of the actively secreting kind.

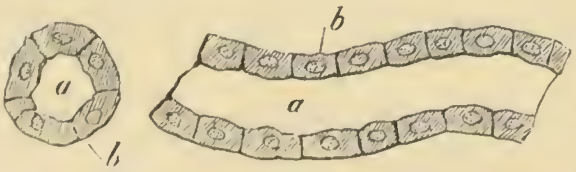


Fig. 160.—Very highly magnified view of section of a tubule, cut across and in its length. *b*, cells; *a*, channel of a tubule.

THE BLOOD-VESSEL ARRANGEMENTS OF THE KIDNEY.

It has been mentioned in passing that the expanded ends of the tubules contain bundles of fine blood-vessels. Each kidney receives an artery from the main arterial trunk—the aorta—as it passes through the belly. The artery, after entering the kidney, splits up into various branches, which penetrate into the substance of the kidney. They reach the junction between the cortex and medullary regions, from which twigs pass up between groups of the convoluted tubules towards the surface of the kidney. On their way they give off branches. These branches penetrate the expanded ends of the tubules and immediately break up into a ball or tuft of capillaries, for which the expansion serves as a covering or capsule. The ball of capillaries is called a **glomerulus,** and it, together with its capsule, forms a **Malpighian body** of the kidney. The capillaries ultimately reunite to form a small vessel which passes out of the capsule, and speedily thereafter that outgoing vessel gives rise to a number of capillary blood-vessels which ramify over the convoluted tubules, affording, we may suppose, nourishment to their cells. These capillaries are then gathered together to form a small vein which joins other veins till large veins are formed, whose junction forms one large vein which goes off from the kidney, carrying away the blood brought by the artery and pouring it into the vena cava (Fig. 157). Other arterial twigs proceed from the junction of medulla and cortex into the region of the pyramids of straight tubes, over which they ramify, to end in veins as the others. The chief point to notice is that the vessel that enters the capsule—the **afferent**

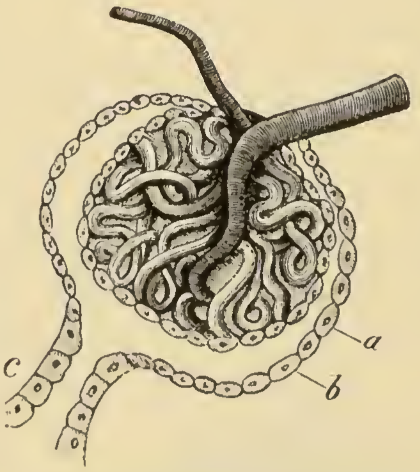


Fig. 161.—Malpighian Body of Kidney, with its tuft of vessels.

a and *b*, cells of capsule formed of widened end of tubule *c*. The wide vessel is the afferent; the narrow one is the efferent.

vessel (Latin, *ad*, to, and *fero*, I carry)—gives rise, directly or indirectly, to two sets of capillaries, those of the glomerulus and those that proceed from the vessel that issues from the capsule—the **efferent vessel** (*ex*, out of, and *fero*). *The outgoing vessel is smaller than the ingoing*; and the significance of this will appear immediately. Fig. 161 represents a Malpighian body with its entering and issuing vessels, surrounded by the capsule, the blind end of a tubule. Fig. 159 is a representation of the afferent vessel (1), arising from an arterial branch, forming the glomerulus, which ends in the efferent vessel (2), whose capillaries ramify over the convoluted tubes and end in a venous twig. In the Malpighian body the tuft of vessels is covered with a layer of small cells, so also is the inner surface of the capsule.

These details of structure show, to a great extent, how the kidney discharges its duties in separating waste matters from the blood, and what is the nature of the apparatus by which this is effected.

THE FUNCTIONS OF THE KIDNEY.

The business of the kidney is to separate certain substances from the blood which have gained access to it in its course through the body, and are the result of the decompositions effected in the tissues by their activity. The chief of these substances removed by the kidney is urea, a solid crystalline body. But the excretion of the kidney is a fluid—the **urine**—in which urea and various other organic and inorganic substances are in solution. What is known of the structure of the kidney indicates that in the formation of the urine there are two processes at work. One process is performed in the Malpighian bodies. An artery enters the capsule of the body and immediately breaks up into a tuft of capillaries. Now the blood is always exerting considerable pressure on the walls of the vessels, and the capillary vessels are very thin walled. One would at once conclude that fluid would ooze through the thin capillary walls and be received in the capsule. The capsule is the expanded end of a uriniferous tubule, so that the escaped liquid would find its way down the tubule, and so into the pelvis of the kidney, into which the tubule opens. As it collected in the pelvis it would flow into the ureter and so reach the bladder. In short, the structure of the Malpighian body suggests that it is a sort of filter, the filter being formed by the thin walls of the blood-vessels of the tuft with the fine layer of cells which covers them, having on one side of it blood under pressure and on the other side the cavity of the capsule (see Fig. 161). As the blood streams through the capillary tuft, fluid filters from it into the capsule, and the greater the pressure of the blood the more fluid will be passed through. Force and confirmation are given to this view by the fact that the vessel, which the capillaries of the Malpighian body form, and which leaves the capsule, is narrower than the entering artery. The supply pipe is larger than the escape pipe; blood passes into the Malpighian body more readily than it escapes from it. Consequently the blood in the capillaries will be at greater than usual pressure, and filtration of liquid from it will be encouraged. The structure of the apparatus, therefore, suggests that one part of the process of urine formation consists in the separation from the blood by filtration of certain of its fluid constituents. This does not, however, appear to be all. As soon as the blood has passed out of the Malpighian bodies in the efferent vessel it is distributed over the convoluted tubules by fine capillary blood-vessels into which the outgoing vessel breaks up (see Fig. 159). Now the convoluted tubules consist of a very delicate wall lined within by large active cells (Fig. 160), and blood is brought in thin-walled vessels into intimate connection with the tubes. These are just the conditions of secretion. The active cells of the tubules are separated from nourishing blood only by the thin walls of the tubes and vessels. It is therefore probable that the cells separate certain substances from the blood, which they work up and then pass into the tubule among the fluid filtered into the capsule and finding its way down towards the ureter. It has been, therefore, concluded that the process of formation of urine consists of two parts: (1) of a separation of fluid parts of the blood *by filtration* in the Malpighian tufts, and (2) of a separation *by active cells* from the blood of probably more solid substances, which are added to the filtered fluid in its course down the tubules.

To this view of the action of the kidney there is one great objection. The blood is an albuminous fluid (pp. 294–295). Careful experiments have shown that if an albuminous fluid be placed on a filter the liquid that passes through contains albumin, though in much less quantity than the original fluid, and that if the solution on the filter contains saline substances dissolved in it, these hinder the passage of the albumin, though they do not arrest it altogether. The experiments have also shown that as more pressure is exerted on the fluid on the filter more albumin will pass through with the fluid. If, therefore, the urine is largely a filtration from the blood under pressure, the fluid ought not only to contain some of the salts of the blood, but also some of the albumin, though less albumin ought to exist in the urine, because the blood is a saline solution, than would be if the blood were only albuminous and contained no salts. In health, however, the urine contains not a trace of albumin. Indeed, if a physician finds albumin in the urine of a patient he regards it as a grave sign of disease. It is then not easy to understand why, if the urine is mainly a filtration from the blood, it does not in health contain albumin. A view which explains this curious fact is that the fluid as filtered through the vessels of the Malpighian tufts is albuminous, but that, as the urine passes down the convoluted and other parts of the tubules, the active cells, lining their channels, seize on the albumin and pass it back into lymphatic channels, so that it may be again restored to the blood. When, therefore, the urine reaches the end of the tubule, and flows into the pelvis of the kidney, it has been entirely deprived of the albumin it possessed as it left the Malpighian capsule. It may be added that by this view one is able to explain various forms of severe disease of the kidney grouped under the term Bright's Disease, of which one of the most important symptoms is the occurrence of albumin in the urine. If the pressure of blood be very greatly increased in the capillaries of the Malpighian bodies, so much albumin may thereby be passed through that the cells are not able to pick it all up, some escapes them and is detected in the urine. Again, the cells may be paralysed or otherwise rendered unfit for their duty by some condition of the blood, or they may have been destroyed by disease. In such a case, though the albumin filtered from the blood is in ordinary quantity, it is not picked up by cells of the tubules, and again its occurrence is detected in the urine. (Refer to the description of Bright's Disease in the following section on Diseases of the Kidney.)

THE URINE.

Physical Characters of Urine.—The characters of the urine excreted by the healthy kidney are well defined; and they undergo marked alterations in disease. It will, therefore, be of value to state here the characters and chemical constitution of healthy urine and the chief alterations urine undergoes in disease. This will be of great value in understanding the results of the diseased conditions of the kidney described in the section which follows.

Urine when freshly passed is of an amber **colour**, clear and transparent, and with a peculiar aromatic **odour**, and of slightly acid **reaction**.

Its **specific gravity** is usually about 1020.

The **quantity** passed in 24 hours by a healthy adult man is between 50 and 60 fluid ounces. It varies not only according to the quantity of water taken in by the mouth, but according to the external temperature and the amount of exercise. The kidneys and skin co-operate to this extent, that if much water is removed by the skin as sweat, as in warm weather and after exercise, less is expelled by the kidneys. In cold weather the skin is less active, and a greater quantity of water will be produced by the kidneys.

Nervous influences also affect the quantity. Thus after hysterical attacks a large quantity of clear urine is often passed. In many persons also excitement of any sort is attended by a very rapid secretion of urine, producing great discomfort if they are in circumstances hindering the emptying of the bladder. This should be remembered in the case of children to whom the pleasure of some entertainment is frequently lessened by a similar circumstance.

Chemical Constitution of Urine is shown in the following table:—

	In 1000 parts.	Quantity in 24 hours varying from
Water	958	
Solids	42	
The solid constituents are—		
Urea	23·3	400 to 600 grains.
Uric acid	0·5	5 ,, 12 ,,
Chloride of sodium (common salt)	11·0	150 ,, 200 ,,
Phosphoric acid	2·3	48 ,, 54 ,,
Phosphates of lime and magnesia	0·8	11 ,, 16 ,,
Sulphuric acid	1·3	23 ,, 38 ,,
Ammonia	0·4	9 ,,
Free acid	2·0	30 ,, 60 ,,
Various other substances—Kreatinin, hippuric acid, &c., in very small amount.		

The average quantity in 24 hours is of water 52 ounces, of solids 840 to 920 grains.

Gases, principally carbonic acid gas, nitrogen and oxygen being in very small quantity, are also contained in urine to the amount of nearly 16 per cent.

The solid constituents consist of two classes of substances: (1) inorganic salts, namely, common salt (chloride of sodium), sulphates, and phosphates, and (2) organic bodies, bodies containing nitrogen, namely, urea, uric acid, hippuric acid, kreatinin, &c. It is instructive to observe the sources of these substances. Chlorides occur in all the fluids of the body; sulphates arise from the decomposition of albuminous bodies; and phosphates have as their source albuminous bodies, the phosphates existing in bone, and phosphorus present in nervous structures. An excess or diminution in the quantity of any of these substances cast out of the body may thus aid in the recognition of a disease. Thus the quantity of phosphates in the urine is increased in diseases of nerve-centres and of bone.

The chief constituents, however, are the nitrogenous, urea and uric acid, the former specially, of which a large amount is excreted, as indicated in the table.

Urea contains the four elements, nitrogen, hydrogen, oxygen, and carbon, nitrogen forming half its weight. While, therefore, the lungs expel from the body carbonic acid in particular, the kidneys expel nitrogen. Both of these substances show decompositions going on in the body, the carbonic acid being the result of the breaking down of starch, sugars, fats, and albumin also, while urea and uric acid are the products of the decompositions of nitrogenous bodies only, of which albumin is the type.

The quantity of urea is always increased by a diet rich in albuminous food-stuffs. It is the last stage in the oxidation process which such food-stuffs undergo in their transit through the body. If it be not excreted by the kidneys, a condition known as **uræmia** arises, described on p. 400.

Uric acid probably represents a stage in the oxidation of nitrogenous bodies not so far advanced as urea. In human urine its quantity is very small (see table). In fevers and other unhealthy states of body its quantity is greatly increased, and since it is more easily dissolved in hot solutions than in cold, when the urine cools it becomes deposited in the form of a brick-red precipitate, making the urine muddy. When in excessive quantity, as in rheumatism and gout, it may form deposits in kidney or bladder, leading to the production of "stone," and in gout it is deposited in the fibrous structures around joints in the shape of chalk-stones.

Some **colouring matter** is also present in urine.

UNUSUAL CONSTITUENTS OF URINE.

The chief abnormal constituents of urine are albumin, sugar, bile, blood, and chyle.

When albumin is present in urine it, as a rule, indicates some disease of the kidney, to which the term **albuminuria** has been applied.

The presence of sugar indicates the disease **diabetes**. Both diseases are commented on in the succeeding section. Bile is another unusual constituent of urine, appearing in jaundice (p. 274).

The appearance of blood is spoken of on p. 409.

THE URETER AND BLADDER.

THE URETER.

The tube which leads from the kidney to the bladder is called the ureter. Its position is shown in Fig. 157 (p. 393). It enters the bladder at the lower part, behind and to the side of the middle line. In length it is from 16 to 18 inches, and is about the size of a goose-quill. It is formed of an outer fibrous coat, a middle muscular coat, and an inner mucous lining with stratified epithelial cells (p. 55) on its free surface. To its walls blood-vessels and nerves are distributed. Its channel is narrow, and it can be easily understood that if a stone has been formed in the kidney, and gets forced into the ureter, its passage down that channel will be accompanied by excruciating pain. The urine is conveyed from the kidney to the bladder by a wave of contraction passing along the ureters from the kidney to the bladder. It reaches the bladder, not in a constant stream, nor yet in occasional gushes, but drop by drop, so that it gradually accumulates there.

The ureters open slantingly into the bladder, so that the urine finds its way into the bladder easily, but could not be readily forced up the tube from the bladder.

THE BLADDER.

The bladder is situated in the pelvis (p. 63, and Fig. 157, p. 393), in front of the termination of the large bowel. Its front face is in contact with the inner surface of the junction of the pubic bones (*sp.*, Fig. 24, p. 63); and when it is full the top of the bladder projects above the bone. It is in this position that pain is felt when the bladder is strained by overfulness. When full the bladder is pear-shaped, when empty it is collapsed and lies low in the pelvis. It consists of three coats, an outer fibrous layer, a middle of muscle, of the unstriped variety, whose fibres run in bundles forming an irregular net-work, and an inner mucous layer with many layers of large epithelial cells on its surface. The peritoneum (p. 189) also in part covers the organ. From the small end of the bladder a canal passes—the **urethra,**—into which the bladder opens, and by which it is put in communication with the outside. The narrow end is called the neck of the bladder, and is surrounded, at the junction with the urethra, by a special bundle of muscular fibres, called the **sphincter of the bladder.** Urine cannot escape from the bladder unless the guard of the sphincter is relaxed.

The **functions** of the bladder are to collect and retain the urine from the kidneys until a certain quantity accumulates, and then to expel it in a stream. The urine enters its receptacle from the ureters drop by drop, and when the bladder becomes distended its emptying is effected apparently by a reflex nervous act (p. 132). An impression passes to a centre low down in the spinal cord. An impulse is thus originated by which the sphincter muscle is relaxed and the muscular walls of the bladder caused to contract. The channel being open, the contraction of the walls exerts pressure on the contained fluid, which is thus expelled. Nervous diseases may affect the act of expulsion. The tone of the sphincter may be lost, so that the urine cannot be retained, or the bladder may be paralysed, so that the fluid cannot be driven out. Irritations may exist about the neck of the bladder, or about the private parts, or due to worms in the bowel, which set up the reflex act and lead to a too frequent desire to empty the bladder. This is a frequent cause of children wetting their beds at night, the irritation originating the whole process, while the children are unconscious of it. Again, there may be some obstruction to the escape of the urine. Nevertheless, the process being involuntary, the contractions of the bladder are set up, all the more vigorously since they are opposed, and thus the severe pain arises that is common in this condition. To this extent the action is voluntary, in that the result of the process may, for a time, be prevented by the will, or may be aided by voluntary effort producing contraction of the walls of the belly, and thus exerting pressure on the bladder.

The Prostate Gland.—In the male this is a glandular body which surrounds the urethra —the urinary outflow-tube—where it joins the bladder. It lies in the middle line behind the pubic bone, is cone-shaped with the point forward, and is about 1¼ inch long in the adult, 1½ inch wide, and 1 inch thick. It consists of two lobes which meet and are continuous in the middle line. Its posterior surface rests on the front wall of the rectum—the end of the bowel. It is richly supplied with blood-vessels and nerves. Through the whole length of this structure the urinary canal passes before it opens in the bladder. Any overgrowth of this structure — hypertrophy, — which is common after sixty years of age, or any tumour, may very seriously interfere with the calibre of the urinary canal passing through it, while any irritation or inflammation cannot fail to proclaim itself during the passing of water, and during the emptying of the bowel.

SECTION XIX.

THE KIDNEYS AND BLADDER.

THEIR DISEASES.

Diseases of the Kidney:
- *Congestion;*
- *Inflammation* (*Nephritis*)—Bright's Disease—Uræmia;
- *Suppuration;*
- *Inflammation of the Pelvis of the Kidney* (*Pyelitis*);
- *Gravel and Stone*—Renal Colic;
- *Dropsy;*
- *Rare Diseases* of the Kidney—Cancer—Tubercle—Tumour—Movable Kidney.

Unusual Conditions of the Urine:
- *The Examination of the Urine*—the detection of albumin, sugar, bile, blood, &c.
- *Albumin in the Urine* (*Albuminuria*);
- *Polyuria* (*Diabetes Insipidus*);
- *Sugar in the Urine* (*Diabetes Mellitus*);
- *Blood in the Urine* (*Hæmaturia* and *Hæmatinuria*),
- *Chylous Urine;*
- *Suppression of Urine;*

Diseases of the Bladder:
- *Inflammation* (*Cystitis*);
- *Irritability;*
- *Paralysis;*
- *Retention and Incontinence* (dribbling) *of Urine* by the Bladder;
- *Stone* in the Bladder; *Cancer and Tumours;*
- *Disease of the Prostate Gland.*

DISEASES OF THE KIDNEYS.

CONGESTION, INFLAMMATION, AND SUPPURATION—BRIGHT'S DISEASE.

Congestion of the kidney implies overfulness of the blood-vessels of the organ. This, it is plain, may be either because a much larger quantity of blood than usual is streaming into the kidney by the arteries, in which case the congestion is said to be *active*, or because, the usual quantity passing in by the artery, it is hindered in its escape along the veins, in which case it is called *passive*. Active congestion may be the preliminary to fully developed inflammation; it may be the result of exposure to cold; it often is due to the irritant action of a poison circulating in the blood, such as that of scarlet fever, measles, or typhus, or the effect of the action of some medicine, Spanish fly, turpentine, or cubebs. Thus irritation of the kidneys often occurs through the application of a fly-blister. The passive form arises when there is obstruction to the circulation, leading to accumulation of blood in the veins. Heart and lung diseases are frequent causes. Pressure on veins by a tumour will readily produce it, and thus in pregnant women the enlarged womb sometimes obstructs the flow of blood in the veins.

The **symptoms** are mainly connected with the urine, which may be increased in quantity and pale, while the patient complains of tenderness or some degree of heavy pain in the loins. Such symptoms would indicate active congestion. Usually, however, the quantity of urine is diminished, is high-coloured, and contains albumin, and sometimes blood, and what are called tube casts. The method of detecting these is described on p. 407.

The **treatment** consists of rest in bed, hot applications over the loins or a warm bath, and a brisk dose of purgative medicine. But since the commonest cause of congestion is an obstruction to the circulation, its seat would require to be made out, and the treatment directed to aid its removal. That would imply an examination of heart and lungs, &c., which only a physician could properly perform.

Inflammation of the kidney (*Nephritis*. Greek, *nephros*, the kidney—*Bright's Disease*—*Albuminuria*). There are various kinds of inflammation of the kidney dependent on the fact that the whole structure of the kidney is not at first attacked, the disease beginning at first only in the tubules (p. 393), or in the blood-vessels (p. 394), or in the fine connective tissue which acts as a framework for tubules and vessels; though after it has begun in one of these it tends to pass to the others. Of late years different names have been given in order to signify in what portion of the kidney structure the inflammation has begun. All the various kinds are included under the general term **Bright's Disease**, because it was Dr. Richard Bright, of London, who first, in 1837, showed the relation between certain symptoms, namely, the presence of albumin in the urine and dropsy, and alterations in the structure of the kidney. One symptom is common to all the forms of the disease, that is, the presence in the urine, in greater or less quantity, of albumin, which, as has been noted on p. 396, is never present in healthy urine. Hence another general term is sometimes employed to include the various forms of the disease, a term which simply points to the main symptom—albumin in the urine,—the term **albuminuria**.

For the purposes of this work the simplest way of describing the various forms of inflammatory disease of the kidney will be to divide them into acute and chronic forms.

In **Acute Bright's Disease** it is the uriniferous tubules (p. 393) that are specially attacked. They become altered, and the cells which line them are swollen and cloudy. The flow of blood to the organ is excessive, so that it is congested. Fluid escapes from the vessels into the tubules, clotting there and so blocking the tubes, or blood may pass by rupture of the overloaded vessels. The cells tend to become fatty and to break down. The clotted material may be swept out of the tubes by the urine in the shape of casts of the tubes, as well as the diseased cells shed from the tubes, and blood, so that these all appear in the urine when passed, and may be detected by appropriate means (see p. 404). The inflammation may so affect the kidneys that they are unable to discharge their function, urine ceases to be secreted, and the accumulation of waste matters in the blood causes death. The inflammation may cease before serious changes have occurred, and recovery then take place. It may gradually pass off, leaving blocked tubules, tubules stripped of their cells, blood-vessels thickened, &c., from which ultimate recovery may result so far as the patient's health is concerned, though the structure of the kidney has been permanently affected; or the disease may become chronic.

The commonest **cause** is exposure to cold and damp. It occurs frequently in the progress of scarlet fever, also during diphtheria, measles, typhus, and erysipelas, and other diseases. *It may follow excessive drinking.* Intemperate habits greatly favour its occurrence.

The **symptoms** of this acute attack are as a rule comparatively sudden in their onset. Chilliness followed by shivering fits and fever, accompanied by headache, thirst, dryness of the skin, sickness and vomiting, are the indications of some serious disorder. The seat of the disease is specially marked out by aching across the loins, it may be mere uneasiness or dull pain. Dropsy, however, is one of the most important signs. It comes on often rapidly, and is specially observable in the face, which becomes puffy, and has a peculiar blanched look. It is earliest seen in the eyelids, and is also common about the ankles, and may be so great as totally to alter the appearance of the patient. The urine undergoes decided alterations. It is diminished in quantity, though it may be passed more frequently than usual, is high-coloured, and has a copious sediment. Examination (p. 406) reveals the presence of albumin in greater or less quantity, blood also and tube casts (p. 407). A sense of heat and pain generally accompanies its discharge. In very severe cases the secretion of urine almost or quite ceases. This is termed **suppression of urine**, that is, no urine is formed by the kidney, and is to be distinguished from **retention of urine**, in which urine is formed, but some obstacle to its discharge exists. Resulting from suppression is the condition termed **uræmia**, a condition due to the retention of waste matters in the blood which the kidneys ought to separate out, but are rendered unable to do. Its symptoms are headache, mistiness of vision, noises in the ears, oppression, dulness, drowsiness, sometimes delirium and convulsions, and it ends in complete unconsciousness (coma) and death. Now, setting aside the symptoms of suppression of urine, the others that have been noted would leave no doubt as to the nature of the disease, and prompt treatment would be necessary. But the symptoms are not so marked in every case. In some cases previous signs of an inflammatory disease are absent and there is no marked pain, the symptoms being limited to dropsy and alterations in the urine. Nevertheless dropsy and scanty albuminous urine are sufficient to warrant the conclusion of the presence of Bright's disease. The symptoms of recovery are lessening of the dropsy, increase in the quantity of the urine, which contains a diminishing quantity of albumin, the skin becoming more moist and of a healthier colour. Recovery may take place speedily within one or two weeks, or may be gradual, occupying several weeks or even months, or the case may pass into a chronic form.

Treatment.—The patient should be kept strictly to bed, clothed in flannel, and his room should be kept warm. Hot applications, poultices containing mustard, if the attack is acute, are useful over the loins; but fly-blisters or turpentine cloths should not be used. The action of the bowels and skin should be aroused. This is done by giving from 20 to 60 grains of the compound jalap powder, repeated every morning or every second morning, as seems desirable. The action of the skin is aided by doses of solution of acetate of ammonia (a dessert-spoonful) and spirit of nitrous ether (half a tea-spoonful) repeated every three or four hours. But for this purpose nothing is so useful and so safe as a hot pack. The patient is rolled, naked, in a blanket wrung out of hot water, and is then surrounded by warm dry blankets. He should be kept in it for an hour or much longer if he feels comfortable. On the hot pack being removed the person should be quickly dried with warm cloths and enveloped in warm flannels. In the absence of medical advice this is the simplest and safest treatment to pursue whenever the symptoms seem urgent. The patient ought also to have plenty of water, lemonade, barley-water, milk, &c., to drink, to help in washing away the material that tends to block up the tubules of the kidney. His diet should be mainly of milk and similar light material. On recovery great precautions must be exercised, as the least exposure might produce a relapse. Flannels should be worn. The food should continue to be of the simplest kind for a long time, milk, rice, bread, plenty of butter, and all kinds of milk puddings without eggs. Quinine and iron should be administered to restore strength and tone.

Persons ought to be warned, however, that this is a most serious disease, even in its apparently mildest forms, and that, whenever possible, nothing should stand in the way of a sufferer from it being placed at once under responsible medical treatment.

Chronic Bright's Disease exists in a variety of forms: (1) as a **chronic affection of the tubules**, the consequence of the acute attack just described, (2) in the form of **cirrhosis** or **thickening**, producing what has been called the **granular, contracted,** or **gouty kidney,** and (3) the **waxy** or **lardaceous kidney.**

The *first form* is frequently the result of taking cold. In it the tubules are permanently affected, their epithelial cells being removed, and the tubes blocked with broken-down material, wasting of the kidney following in time.

Its **symptoms** are chiefly alterations in the character of the urine, and dropsy. The urine is scanty, contains albumin, and the use of the microscope discovers in it numerous cells from the tubules, and casts of the tubules. The patient has a doughy, puffy look, the dropsy filling up the furrows of the face, and giving a smooth, glossy appearance. Outbursts of the acute attack are liable to arise, and inflammatory attacks of other organs and affections of the heart and arterial vessels are not infrequent.

The *second form* is most frequently caused by abuse of spirituous liquors, specially whisky or brandy. It is also associated with gout and with lead poisoning.

In this form the connective tissue between tubules and blood-vessels is the chief seat of the alterations of structure. It is increased in amount and by its pressure on the blood-vessels diminishes their supply of blood while it causes wasting of the tubules. The whole organ becomes greatly reduced in size by the shrinking of the connective tissue.

Symptoms of the disease may not be evident for a long time, unless they are symptoms of digestive trouble, common in all forms of Bright's disease. Sometimes the patient seeks medical advice owing to failure of sight, when a careful examination of the eye reveals changes in the retina, the nervous coat at the back of the eyeball, associated with a diseased kidney, whose existence was not before suspected. Dropsy may be absent or very slight. The urine is pale, increased sometimes in quantity, but does not always contain albumin, though usually in small amount. Associated with this form of Bright's disease in particular are alterations in the heart and arteries; affections of the lungs are common, bronchitis, pleurisy, &c., and uræmia, described in a previous paragraph, is the common cause of death. Recovery does not take place, but the person may live for many years, as the progress of the disease is very slow.

The *third form* of chronic Bright's disease, that of waxy kidney, is said to be the consequence of prolonged exhausting disease, such as prolonged suppuration, disease of bone, consumption, and syphilis. The kidney becomes altered in structure, the waxy change beginning, it is said, in the blood-vessels and spreading to the tubules, which become blocked up by a semi-transparent waxy material. As a result the kidney wastes and contracts.

Its **symptoms** are ill-defined, like those of the preceding form. The urine is very copious, pale and watery, the patient having to rise several times in the night to void it. It contains little albumin at first, but the quantity increases. There is no dropsy. The patient gradually loses strength, but death may not result for several years, even five or ten, and is more commonly due to complications than to the disease itself.

Treatment of chronic Bright's disease.—It is impossible to give detailed instructions as to the treatment of chronic forms of this disease. Its complications, affecting stomach and bowels, lungs, heart and blood-vessels, brain and other important organs are so numerous that the treatment appropriate for each case can only be decided by a physician who knows his work and who takes all the circumstances of the case into his consideration. Sometimes a careful scrutiny will reveal causes of the disease whose removal will tend to considerable improvement in the patient's condition, if not to recovery. Thus gout, syphilis, &c., should be treated if present. A general line of treatment can, however, be indicated, that is suited to all forms of the disease. The patient should avoid all exposure to cold and wet. He may be able to select a warm, equable climate, or a sheltered place of residence where he is not liable to sudden great changes of temperature. He should always wear flannels. He should take moderate exercise, and should attend to the condition of the skin, so that by strict cleanliness, and the frequent use of warm baths (taken, of course, with due precaution against cold), the free action of the skin is aided, and undue labour is thus prevented from being thrown on the kidneys. The bowels should never be allowed to become costive. In short, the patient must be surrounded by the healthiest possible conditions of life. The next object of treatment is the maintenance and, as far as possible, the increase of bodily strength. To this end the most nourishing food ought to be made use of, but of the most easily digestible kind. Milk in quantities may be allowed, and nourishing broths and soups, but the quantity of butcher-meat should be restricted. All albuminous food-stuffs (p. 191) throw work on the kidneys, since the result of their breaking down in the body is the production of urea, whose expulsion it is the business of the kidneys to provide for. Limitation of this kind of food, therefore, diminishes the quantity of urea and lessens the work of the kidneys. Chief among the means of strengthening the body is the administration of iron tonics, in the form of quinine and iron wine, or with strychnine as Easton's syrup (of which ½ to 1 tea-spoonful is a dose for an adult), and other similar preparations. *The use of ardent spirits should in all cases be avoided.* This is a general line of treatment, as already said. The treatment of dropsy, which is sometimes relieved by puncturing the dropsical parts, sometimes by free purgatives and by other means, is entirely dependent on the circumstances of the patient, of which only a medical man can form a proper estimate. It is sometimes very greatly and rapidly reduced by a diet as free of common salt as possible. Food should be cooked and eaten without salt.

Suppuration of the Kidney is an inflammatory disease of the kidney accompanied by the formation of matter. The substance of the kidney is the seat of the disease, in which abscesses may form. It may be caused by inflammation passing upwards from the ureter or bladder, or by the irritation of stone in the kidney, or by a poisoned condition of the blood —pyæmia (p. 315), by injuries, or exposure to cold.

Among its **symptoms** are shivering fits (rigors), pain or uneasiness in the loins, albumin, blood, tube casts and matter in the urine.

Treatment.—This is a disease which will probably demand surgical treatment.

Inflammation of the Pelvis of the kidney (p. 392), called by physicians **Pyelitis**, is another form of inflammation which can only be mentioned in such a work as this. It is caused by exposure to cold, stone in the kidney, by obstruction to the outflow of urine causing it to be retained and to become decomposed in the cavity, or by blood-poisoning, and it is marked by attacks of fever, pain in the loins, and changes in the character of the urine, which contains matter in chronic cases. If the obstruction persist owing to the retained materials, the kidney becomes converted into a tumour with fluid contents—decomposing urine and matter. Such cases as suppuration of the kidney and pyelitis are now, as the result of aseptic methods, successfully dealt with by the aseptic surgeon.

GRAVEL OR STONE: RENAL COLIC: DROPSY OF THE KIDNEY.

Gravel or Stone (*Renal calculus*, Latin, *ren*, a kidney, *calx*, chalk). The urine contains certain substances in solution, whose natural condition is that of a solid, and which, under certain circumstances, tend to separate out and, assuming the solid form, appear as a sediment

PLATE XXIII

THE TOPOGRAPHY OF THE KIDNEYS

BACK VIEW

This plate is to be studied along with Plate XXII.

It shows the location of the kidneys, close to the backbone, and between the lowest ribs and the crests of the haunch-bones, the upper edge of the kidney being on the level of the 11th dorsal spine, and the lower edge a little lower than the level of the 2nd lumbar spine.

The distance between the lower edge of the kidney and the crest of the haunch-bone, roughly shown in outline (I) in the plate, is one inch.

Note how the **ureters (Uret.)** issue from the kidneys about the level of the 1st lumbar spine. Any stone attempting to force its way into the ureter from the kidney would give rise to severe pain in this spot.

The other indications of the plate are to enable this to be studied with the others. Thus the blue outline indicates the area occupied by the lungs (see Plate XX), and shows how little interval separates the top of each kidney from the bottom of each lung. The continuation of the blue outline upwards indicates the direction of the windpipe.

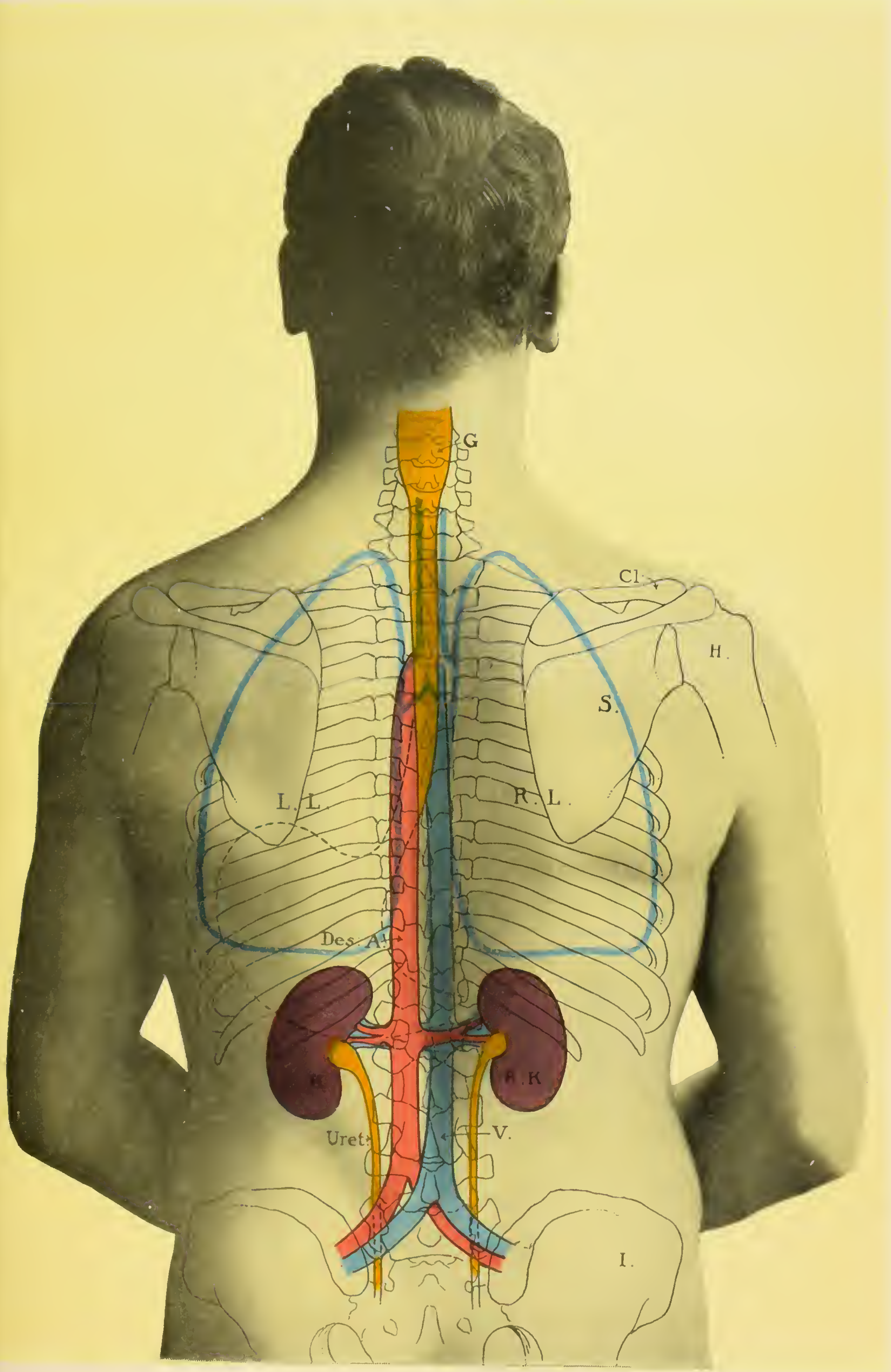
L.L. is left, **R.L.** is right lung.

G. is **Gullet**, and the relation between it and the **descending aorta (Des. A.)** and **ascending vena cava (V.)** is shown.

S. is **shoulder-blade**, **C. collar-bone**, **H. upper arm bone.**

A broken black outline suggests the location of the stomach in relation to these various organs.

PLATE XXIII



THE TOPOGRAPHY OF THE KIDNEYS

(BACK VIEW)

in the urine. The chief of these are uric acid, combinations it forms with soda, ammonia, &c., called urates, and phosphates of lime and magnesia. (See p. 407.) Now uric acid may be present in the urine in excess, and as it is not a very soluble body it is readily crystallized out in the form of red particles. Anyone may cause them to be formed in healthy urine by adding a small quantity of strong hydrochloric acid to the urine and setting it aside in a tall glass for a day or two. In time small red particles will be seen forming on the sides of the glass—these, examined by a lens, are found to be crystals of uric acid. Various bodily conditions, connected specially with the digestive system, produce a deposit of uric acid, conditions due to too free living, excess in sugary and nitrogenous foods, and in heavy wines, beer, &c., indolent habits, and affections of the liver that accompany or are aggravated by such habits. Phosphates are held in solution in urine by its acid character, and if the urine becomes alkaline the phosphates are precipitated. The urine is alkaline in various disorders of nutrition, in nervous dyspepsia, and conditions of general debility; and thus a deposit of phosphates occurs. But after quite healthy urine has been excreted by the kidney, it may undergo decomposition before it is expelled from the body; the result of decomposition is that the urine becomes strongly alkaline, and so again phosphates will be deposited.

Besides these two substances, uric acid and phosphates, there is another, oxalate of lime, which readily separates out from the urine. It should not exist in healthy urine, but appears there as the result of some interference with the due performance of the nutritive processes in the body, it being only a stage in the breaking down of non-nitrogenous food-stuffs.

We see, then, that these three substances, uric acid, phosphates, and oxalate of lime, are liable, under certain circumstances, to separate out from the urine as a deposit. They may exist in the urine, however, in a state of such fineness as only to give an unusual cloudiness to the urine, a microscope being required to reveal that the cloud is actually due to solid particles. They may form larger particles capable of being felt or seen, in which case the deposit is termed **gravel**, while again they may form masses of varying size, to which the name of **calculus** or **stone** is given.

Now the deposit may be formed in any part of the urinary organs, from the urinary tubules or pelvis of the kidney to the bladder. A particle deposited in a tubule may be swept on to the pelvis, may be detained there, and grow in size from successive deposits on its surface, may pass to the bladder, down the ureter, and being detained there continue to grow. There may, therefore, be stone in the kidney or stone in the bladder, or both. A gritty particle of uric acid swept from a urine tubule may become a stone of size before it is finally got rid of. It may reach the bladder as a uric acid particle, and there, owing to decomposition taking place in the urine, it may be coated with phosphates, so that it consists of uric acid in the centre and phosphates outside.

Gravel thus differs from stone only in size; and the size of stone may vary from that of a pin's head to that of a goose's egg. The uric acid stones are the most common. They are smooth, hard, and reddish or yellowish brown in colour. Oxalate of lime stones are next in frequency, and form what is called the **mulberry calculus**, because of their appearance, being of a dirty purplish colour, and with a very irregular and rugged surface. Phosphatic stones are also common. They are smooth, light, and earthy in appearance. There are also stones formed of mixtures of these, as already mentioned, and also of other substances which are too rare to be noted here.

One stone may exist or several. They may be present in only one or in both kidneys. No age is exempt from them. They may be present in the kidney of the unborn child.

Symptoms.—Gravel may be formed in the kidney and passed in the urine without any symptoms being present. Stone may be formed also without any manifestation, and its presence may be revealed only when it happens to be disturbed and makes an attempt to escape in the water. On the other hand, the production and passing of gravel may irritate the kidney and occasion pain in the loins, and frequent desire to make water. The pain often extends downwards towards the groin and bladder, in the direction of the ureter, and is increased by exercise, especially by jolting movements such as riding in a carriage produces. Frequently, also, there is soreness during the passing of water, particularly at the end of the urethra. The urine is occasionally bloody, the blood not being in streaks, but intimately mixed with the urine. When a stone of any size attempts to pass down the ureter, the pain becomes acute, and is apt to occur in paroxysms, occasioning what is called **renal colic**. It begins suddenly, perhaps rises to intense agony, passes down towards the groin and testicle, which is drawn up (retracted), is accompanied by sickness and vomiting, the patient being bathed in warm perspiration, and frequently produces fainting and collapse. The attack lasts a varying time, sometimes a few hours, sometimes, with periods of relief, for days, and usually ends suddenly, either because the stone has reached the end of the ureter and has dropped into the bladder, or because it has been arrested in its course. The passage of one stone does not imply permanent relief, since others may form, and lead to other attacks.

Treatment depends on the condition giving rise to the production of stone. Uric acid stone is most common, and depends on a highly acid condition of the urine, so that steps taken to diminish its acidity will be useful. Moderation in food and drink must be carefully observed, animal food in excess, highly spiced dishes, and heavy wines being specially avoided. Water, barley-water, milk-and-water, should be used freely to dilute the urine, and alkaline mineral waters, particularly Carlsbad, Friedrichshall, and Hunyadi Janos, to reduce the acidity of the urine. Change of air is also of great value. The administration of acetate or citrate of potash, 40 to 50 grains in a wine-glassful and a half of water, three or four times daily, is also highly recommended, to be continued for some months, but suspended for a time if the urine becomes ammoniacal. If oxalate of lime stone is suspected, keeping the urine dilute by the means mentioned above, avoiding vegetables rich in oxalates, such as rhubarb and sorrel, promoting the action of the skin by exercise and bathing, and the use of the mineral waters already indicated, form the treatment. Since the deposition of phosphates depends on alkaline urine, the result of impaired health, tonic treatment is valuable, and the use of dilute nitro-muriatic acid (10 to 15 drops in water after meals) is urged.

The intense pain caused by the passage of a stone is relieved by hot baths, and hot applications to the loins and side. Opium or morphia in repeated doses is often necessary, but their administration is only safe in the hands of a medical man. Inhalation of chloroform may be necessary in the agony of an attack.

Dropsy of the Kidney (*Hydronephrosis*, Greek, *hudōr*, water, and *nephros*, the kidney). This is a chronic disease due to an obstruction to the escape of urine from the kidney. The obstruction is in the ureter and may be in any part of its course, frequently towards the end near the bladder, and often due to a stone arrested in its progress towards the bladder. The result is that the pent-up urine widens the ureter and pelvis of the kidney, leads to wasting of the substance of the kidney by its pressure, so that in the end the kidney may be converted into a sac filled with fluid.

The detection and treatment of the condition it is needless to note here.

RARE DISEASES OF THE KIDNEY.

Cancer, tubercle, and **syphilitic disease** may attack the kidney. Hydatid disease, similar to that occurring in the liver (p. 261), also occurs in the kidney.

Movable Kidney is the term applied when the organ is loosely connected to the wall of the belly, to which it is usually firmly bound, so that its position may be altered in various directions. It is more common in women than in men. It may give rise to no symptoms, or may occasion uneasiness and pain of a sickening kind.

Bandages are used to keep the kidney in position, and in particular cases an operation may be undertaken to fix it to the wall of the belly.

UNUSUAL CONDITIONS OF THE URINE AND THEIR DETECTION.

The Examination of the Urine.—A careful examination of the urine is capable of yielding very important indications of the state of health of a person. Sometimes the presence of a disease, quite unsuspected, is revealed by it, and it is a very common thing for physicians, unable because of vague symptoms to decide what is wrong with a person, to have all doubts set at rest by examining the urine. Moreover, such an examination frequently affords the most reliable evidence as to the progress a sufferer is making, whether towards recovery or towards a more serious state of disease. It will, therefore, not be out of place in a work specially intended for the guidance of persons not acquainted with medical science, to give a brief account of the main steps in such an examination. Besides, such an account will help to show that the modern practice of medicine rests on a really scientific basis, and is not a mere rule-of-thumb, hap-hazard procedure. If this were fully realized by the public, the writer is confident it would lead to them taking greater care to place themselves, when the state of their health demanded it, in the hands of educated medical men, and would impress them with the risks they run in seeking the counsels of quacks and impostors.

The **appearance** of the urine should first be regarded. It ought to be quite clear and transparent, depositing after some time a light cloudy precipitate consisting of mucus from the urinary passages. The urine may grow muddy and cloudy when it has become cool, or soon after being passed. A small quantity should be placed in a test-tube or metal spoon, and *gently* heated over a gas or spirit-lamp flame; if it clears up, the deposit is **urates.** This is due frequently to feverish states, and to disturbance of the digestive system. If the gentle heat makes it more cloudy, a few drops of common vinegar should be added. If it then clears up, the deposit has been **phosphates,** and indicates that the urine has been alkaline. It should be noticed that if the urine has stood for some time this may have been due to decomposition in the urine. For urine when passed should be acid, but after standing for some days it undergoes decomposition and becomes alkaline, when phosphates are precipitated, making it muddy. It is only when phosphates appear in freshly-passed urine, or in urine quite recently passed, that they are significant. Then they indicate decomposition occurring in the bladder, or an altered condition of blood and nutrition, requiring further investigation.

The nature of deposits other than those mentioned is determined by means of the microscope.

The **colour** of urine varies with the degree of its concentration. That which deposits urates is high-coloured. Other very high-coloured urines should be tested for blood and bile as mentioned further on.

The **quantity** of urine passed in 24 hours is between 2½ and 3 pints. It varies with the quantity of water taken, and with the activity of the skin, being less when the skin is active, as in warm weather, when it is of a darker colour, and greater when the skin is less active, as in cold weather, when it is pale and limpid. Nervous persons pass a large quantity of clear urine of low specific gravity (see POLYURIA, p. 407). When a constantly large quantity of urine is passed, it ought to be examined for sugar (see DIABETES, p. 407). Persons ought to distinguish between passing a large quantity of urine and passing it often. Irritability of the bladder will cause frequent desire to pass water, and the person may conclude that an unusually large quantity is voided. This is settled by collecting all that is expelled in 24 hours and measuring it. A constantly small quantity ought to lead to investigation for kidney disease.

The **determination of the specific gravity** of the urine is the next step in a systematic examination of the fluid. This is done usually by means of an instrument called a **urinometer,** shown in Fig. 162. It consists of a glass bulb of an oval shape, loaded at one end by a small quantity of mercury, and prolonged, at the other end, into a stem which has a series of marks on it at regular intervals, each mark having a number attached. The instrument is so constructed that if it be immersed in a tall glass containing distilled water it will sink in the water for a certain distance and then float with the stem upright. The water will reach to the top score on the stem, marked 0. Now if 10 ounces of common salt be dissolved in 1000 ounces by weight of distilled water, and if the tall glass be nearly filled with this solution, and the urinometer placed in it, it will sink till the stem is immersed up to the mark 10, indicating that there are 10 parts of solid matter in every 1000 parts of the fluid. Suppose now the tall glass be nearly filled with urine, and the urinometer be placed in it, the level to which the stem is immersed in the urine can be read off, and thus the quantity of solid matters ascertained. If the urinometer floats at the mark 20, that means that in every 1000 parts of such urine there are 20 parts of solid matters dissolved, and so on. The specific gravity of urine is usually about 1020. But it varies with circumstances. Thus if the skin be very active or the weather hot, a large quantity of water will escape by the perspiration, the quantity of water expelled by the

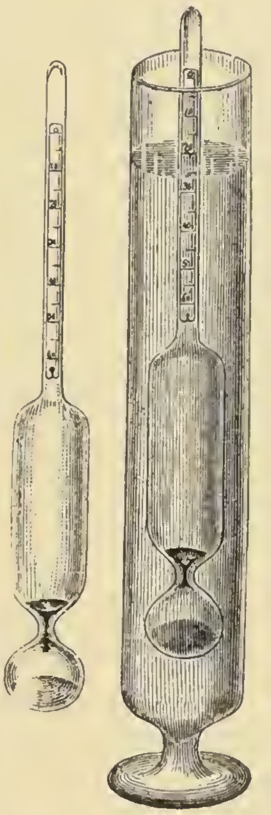


Fig. 162.—Urinometer.

kidney will be less, and the urine will contain a greater quantity of solids in proportion to its liquid parts. Again, if a large quantity of water or other dilute fluids be drunk, more water will escape from the kidneys and the urine will be more dilute. In order not to be misled by temporary variations one ought to collect all the urine passed in 24 hours, mix it, and take a sample of the mixture.

A low specific gravity, 1015 or thereby, should lead to testing for albumin, not because the presence of albumin lowers the specific gravity, but because in albuminuria there is frequently a diminished quantity of the usual solids of the urine. A high specific gravity, 1030, 1035, &c., almost surely indicates diabetes.

The **acidity or alkalinity** of the urine is determined by the use of blue litmus paper, which remains blue if dipped into an alkaline fluid, but is changed to red if the fluid be acid. As already stated, healthy urine is feebly acid when passed. After a little it becomes more acid, and then, with decomposition, it becomes alkaline. Urine may be affected in this direction by food and drugs, a diet rich in animal food rendering it highly acid, and one rich in vegetable food or alkaline drugs (soda, potash, &c.) tending to make it alkaline. If there is no reason in the food for one condition or the other, further examination is necessary, lest the high degree of acidity indicate excess of uric acid in the system, as in gout or in the condition tending to the formation of uric acid stone, or lest, on the other hand, some affection of the bladder be causing premature decomposition of the urine and its consequent alkalinity, or lest some other serious condition of body be present.

The **detection of albumin** in the urine is of great importance. A small quantity of urine is heated to boiling in a test-tube over a gas or spirit-lamp flame, a few drops of acetic acid being added. If albumin be present in any quantity a white flaky precipitate appears, the thickened albumin. Anyone can imitate this test by mixing a small quantity of white of egg with water, placing it in a test-tube and boiling. In extreme cases the urine may become almost solid. A simple way of performing the test is to take some urine in a metal spoon, add a few drops of vinegar, and heat to boiling. If albumin be present in very small quantity this test is not delicate enough. A more satisfactory one is afforded by pouring the urine into a test-tube to the depth of from 1 to 2 inches, inclining the test-tube to one side, and pouring down the side gently, and drop by drop, strong nitric acid to the extent of half the quantity of urine. Then gently raise the test-tube to the upright position, taking care not to shake the fluid. The nitric acid and urine will be found to form two layers distinct from one another, the heavy nitric acid at the bottom of the tube and the urine above it. If albumin be present a white cloud appears at *the junction of the two fluids.* The success of the test largely depends on the two fluids being kept from mixing.

To detect bile take a small quantity of urine in a test-tube, drop in a small morsel of lump-sugar, incline the test-tube, and slowly pour down the side a quantity of strong sulphuric acid (oil of vitriol) equal to that of urine. The acid forms a colourless layer at the bottom, urine is above it, and the piece of sugar is between the two. Raise the test-tube and watch the junction between the two layers, the fluids being kept from mixing by shaking being prevented. The appearance of a deep-purple colour indicates the presence of bile. A dark-brown colour of burnt sugar, caused by the action of the acid on the sugar, must not be mistaken for the purple. Bile is present in the urine in jaundice and diseases of the liver, to which refer (pp. 272 to 274). Another method consists in pouring some urine on a white porcelain plate and pouring beside it some drops of *fuming* nitric acid (nitric acid containing nitrous acid). At the junction of the fluids there appears a play of colours, beginning with green and going on to blue, violet, red, and ending in yellow. Both these tests give satisfactory results only in experienced hands.

To detect sugar in urine there are various tests. Fill a test-tube to one-third with urine, add an equal quantity of liquor potassæ, and boil the top of the mixture by causing the flame of a spirit-lamp to play on the side of the tube. The appearance of a sherry-brown colour, deepening on continued boiling, indicates the presence of sugar. Another test consists in adding a drop or two of solution of sulphate of copper to urine in a test-tube, then enough liquor potassæ to give a clear dark-blue solution, then boiling the surface of the mixture. If sugar be present a red or orange coloured precipitate appears. The presence of sugar indicates diabetes.

By examination with the microscope the presence of blood (see **Hæmaturia**, p. 409), matter, crystals of uric acid or oxalate of lime (see p. 403), cells from the kidneys or urinary passages, casts of the tubules of the kidney, produced by material capable of clotting being poured into the tubes as a result of inflammation (see Bright's Disease), and other unusual constituents may be detected. The urine is allowed to stand for some time in a conical glass. A glass tube drawn to a fine point is passed down to the bottom, and a few drops of the fluid are withdrawn. A drop is placed on the centre of a glass slide used for microscopical purposes, and covered with a cover-glass. The slide is placed on the stage of a microscope and examined with a lens magnifying by 300 diameters. The forms of these various bodies are exhibited in Fig. 163.

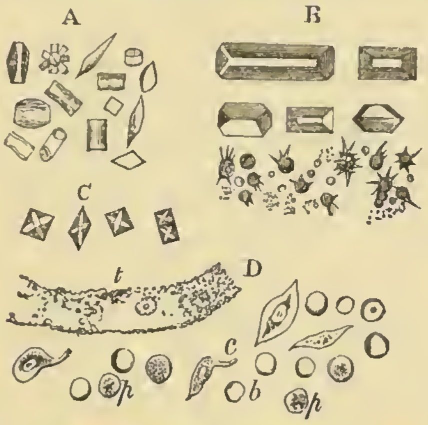


Fig. 163.—The Microscopical Appearance of certain Deposits of Unhealthy Urine.

A, Various crystals of uric acid, found in acid urine. B, The larger crystals are phosphates. These are found in alkaline urine. The small spiked balls, &c., are urates of ammonia. C, Crystals of oxalate of lime (see p. 403). D, Organized deposits; *t*, tube cast; *b*, blood cells; *c*, cells of the kidney or bladder; *p*, pus cells (matter).

Albuminuria is the condition in which albumin is found to exist in the urine. It is a symptom of disorder of the kidneys. (See Congestion of the Kidneys and Bright's Disease, p. 399.) The tests for albumin in the urine have been mentioned on the preceding page.

Polyuria (*Diabetes Insipidus*) is a disease characterized by the passage of large quantities of urine of low specific gravity (1001 to 1010), and without the presence of albumin or other unhealthy constituent.

It is a curious and rare disorder, its cause being not understood. It is hereditary and has been known to be transmitted through four generations, and is related to true diabetes, in which sugar is present in the urine. It may occur at any age and to either sex. It may exist in the newly-born child, and is rather more common in early than in later life. It is supposed to be connected with tuberculosis (Sect. XVII.), disease of the brain, and intemperance. Its supposed connection with nervous disease is strengthened by the fact that the famous French physiologist, Claude Bernard, who found that a puncture in the floor of the fourth ventricle of the brain (p. 135) at a particular spot occasioned true diabetes, found also that a puncture in a slightly different situation produced polyuria.

Its chief **symptom** is the excretion of large quantities of urine, even larger quantities than in true diabetes. The urine is of low specific gravity and contains no albumin or sugar. Pailfuls of urine may be passed daily, and the person is tormented by constant desire to drink, and to pass water. Thirst is present, and occasionally the appetite is great. A patient of the French physician Trousseau, was paid by some restaurant keepers not to dine there, since the quantity of bread (supplied without extra charge) he consumed was enormous. Some suffering from this disease can drink large quantities of intoxicating liquors without being in any way affected thereby. In many cases no other symptoms accompany the disease, and the patient may live to a good age. In other cases impaired health follows, though death is usually owing to some other affection.

No **treatment** of special value is known. The diet should be regulated, and tonics (quinine, iron, and strychnine tonic—see Prescriptions) administered. Water should not be withheld. Ergotine, in doses of 2 grains twice or thrice daily, and continued for some time with occasional intervals, might prove of benefit.

Diabetes Mellitus (from Greek, *dia*, through, and *baino*, I flow, and *melitta*, a bee; *Glycosuria —sugar in the urine*) is a disease of which the chief symptom is the presence of sugar in the urine.

Its **cause** is not known. Claude Bernard found that it might be artificially produced in animals by puncturing the floor of the fourth ventricle of the brain. It is sometimes hereditary and may be present at any age and in both sexes, being most common in adults from 25 to 60 years of age.

The **symptoms** are the passing of a constantly excessive quantity of urine, which gradually becomes more and more abundant, thirst, excessive appetite, dry harsh skin, and gradual loss of flesh and strength. These symptoms usually increase slowly.

The urine is pale in colour, with a peculiar sweetish heavy smell; from 8 to 20 or 30 pints may be passed daily; it is of high specific gravity (1030 to 1040); and the presence of sugar is sometimes indicated by the patient noticing that it is attractive to flies, bees, &c. It rapidly ferments if kept in a warm place. The presence of sugar is determined by the tests mentioned on p. 406.

The large quantity passed causes frequent calls to pass water. The thirst cannot be satisfied, and is accompanied by a parched and clammy condition of mouth and throat.

Appetite is often voracious, though in the later stages it may be lost. The tongue is red and irritable, the gums inflamed and the teeth liable to decay. Costiveness is common.

The body is wasted, the strength reduced, and languor and weariness produce disinclination to exertion.

The harshness and dryness of the skin is marked, there is tendency to boils, and wounds do not readily heal. Failure of sight from the formation of cataract is frequent. While these are the symptoms of a marked case, sugar may exist in the urine without any prominent symptom leading to its detection. Specially is this liable to be the case when the disease begins in persons advanced in life. In such cases an intolerable itching about the genital organs may be the symptom which leads to an examination of the urine and the detection of sugar, of which no other marked symptom is present. Stout people advanced in life may thus be affected without losing their stoutness, in whom dyspepsia and general weakness are the chief complaints. In such patients recovery is much more probable than in the fully evident disease, and the complaint is in no way so distressing.

The disease is essentially a chronic one, though death occurs, in some cases, with great rapidity. The younger the patient the more grave is the disorder. From six months to three or four years is the duration of the disease, and it terminates by exhaustion or by other induced diseases.

Consumption is liable to attack and carry off a diabetic person. Death sometimes occurs by coma (unconsciousness), diabetic coma, and then it may be sudden.

Treatment.—The chief treatment consists in regulation of the diet. All articles containing sugar or starch (which is converted into sugar in the body) should be rigidly excluded. To show what substances may be eaten, because of absence of sugar or starch, and what may be drunk, as well as what ought to be avoided, because of the sugar or starch they contain the following tables from Pavy are given:—

THE DIABETIC PATIENT MAY EAT

Butcher's meat of all kinds, except liver.
Ham, bacon, or other smoked, salted, dried, or cured meats.
Poultry. Game.
Shell-fish, and fish of all kinds, fresh, salted, or cured.
Animal soups not thickened, beef-tea, and broths.
The almond, bran, or gluten substitute for ordinary bread.
Eggs dressed in any way.
Cheese. Cream cheese.
Butter. Cream.
Greens. Spinach. Turnip tops *Turnips.
*French beans. *Brussels sprouts.
*Cauliflower. *Broccoli. *Cabbage.
*Asparagus. *Sea-kale. *Vegetable Marrow.
Mushrooms.
Water-cress. Mustard and cress. Cucumber. Lettuce.
Endive. Radishes. Celery.
Vinegar. Oil. Pickles.
Jelly, flavoured but not sweetened.
Savoury jelly.
Custard made without sugar.
Nuts of any description except chestnuts. Olives.

MUST AVOID EATING

Sugar in any form.
Wheaten bread and ordinary biscuits of all kinds.
Rice. Arrow-root. Sago. Tapioca. Macaroni.
Vermicelli.
Potatoes. Carrots. Parsnips. Beet-root.
Peas. Spanish onions.
Pastry and puddings of all kinds.
Fruits of all kinds, fresh and preserved.

THE DIABETIC PATIENT MAY DRINK

†Tea. †Coffee. †Cocoa from nibs.
Dry sherry. Claret. Dry Sauterne. Burgundy.
Chablis. Hock.
Brandy and spirits that have not been sweetened.
Soda-water.
Burton bitter ale, in moderate quantity.

MUST AVOID DRINKING

Milk, except sparingly.
Sweet ales, mild and old. Porter and stout. Cider.
Lemonade. Ginger-beer, &c.
All sweet wines. Sparkling wines. Port wine.
Liqueurs.

Thus the patient must deny himself sugar in every form, and he must leave ordinary bread, biscuits, potatoes, and sweet vegetables out of his diet. This may be done gradually by dropping potatoes and taking only a small half-slice of bread well toasted, or bran bread well toasted. Special bread is made for the diabetic called gluten bread, made of flour out of which all the starch has been washed. It is

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** Those marked with an asterisk may only be eaten in moderate quantity, and should be boiled in a large quantity of water.*

† With cream but without sugar

unhappily not very palatable, and patients soon tire of it. Almond cakes may be used. For drinking, soda-water, or soda-water and cream is refreshing.

The patient should take regular moderate exercise, flannels should be worn, and warm baths frequently taken.

Many medicines have been tried, but none are very successful. Opium and ergot are probably the best, and may be taken in pill, containing $\frac{1}{2}$ grain powdered opium and 2 grains ergotine, one thrice daily. In many cases the use of opium ought to be pushed, but not without medical supervision.

The liquid extract of the seeds of Jambul—the Java plum (*Eugenia Jambolana—Syzygium Jambolanum*) is a drug worth a trial, in doses of 5 to 10 drops in water two or three times a day. Uranium acetate was spoken of also as sometimes curative, and in France a wine, prepared with it, and called Vin Urané, has been much advertised.

It should not be forgotten that the regulation of the diet is the chief treatment, and that a return to ordinary diet, because of the irksomeness of a restricted one, is almost certain to restore the worst symptoms. Efforts should be made, by constantly varying the kinds of food used, of those recommended in the first list, to diminish as much as possible the feeling of loss because of the want of customary things.

Blood in the Urine (*Hæmaturia and Hæmatinuria*). Blood may exist in the urine under a variety of circumstances. It may come from the kidney, from the ureter, from the bladder, or other parts of the urinary tract. If it come from the kidney it is more likely to be uniformly mixed with the urine, which has in consequence a smoky colour, than when it comes from the bladder, when it is more likely to present the appearances of ordinary blood and to be less mixed with the urine. It may be passed in clots. Congestion of the kidney, or inflammation of various kinds, or the presence of stone may be among its causes, while growths or stone in the bladder commonly produce it. When it is in small quantity the smoky colour of the urine suggests its presence, and this may be most easily verified by discovering blood corpuscles in a drop of the urine examined by a microscope.

Paroxysmal Hæmatinuria is the term applied to a curious affection, due to exposure to cold, in which the patient, after complaining of uneasiness across the loins and chilliness, becomes extremely cold, is pale, has an attack of shivering, shortly afterwards passes urine resembling porter, very dark coloured and muddy, because of the presence of blood. Sometimes sickness and aching in the limbs attend the attack, which soon passes off, but is liable to occur again suddenly after varying intervals. Sometimes the attacks occur after regular intervals. The poison of ague has been said to have a part in the tendency to the disease.

Treatment for bloody urine depends on its cause. When it is coming in any quantity the person should be kept quiet in bed. Cold compresses may be applied over the loins if it is supposed to come from the kidneys, or over the lower part of the belly if it is supposed to come from the bladder. If the discharge is profuse, 5-grain doses of gallic or tannic acid may be administered by the mouth every 5 or 6 hours while necessary, or 15 grains iron-alum dissolved in a tumbler of water should be taken in 12 hours. During the paroxysmal attacks the patient should be kept warm in bed. The prevention of the attacks is more easily accomplished than the treatment. Exposure to cold and wet should be avoided; the person should be clothed in flannel; and quinine and iron tonics should be taken.

In both kinds of cases, however, the determination of the causes of the disturbance is so difficult, and their recognition of so much importance, that no delay should be made in consulting a physician.

Chylous Urine (*Chyluria*) is a condition in which the urine is milky from the presence of chyle or lymph (p. 276), and clots, like size, on standing. It is a disease of tropical climates. In many cases the disease has been associated with a worm, the *Filaria sanguinis hominis*, occurring in the blood.

Suppression of Urine is the term applied when no urine is passed from the kidneys. It is to be distinguished from retention of urine (p. 411), in which the kidneys form urine which accumulates in the bladder. It is a very serious condition, occurring in the course of cholera, certain infectious diseases, and inflammations of the kidneys, and if continued leads to uræmic poisoning (p. 400). In cases of hysteria suppression of urine may last for some time without any symptoms of uræmia.

DISEASES OF THE BLADDER.

Inflammation of the Bladder (*Cystitis*) is of the nature of catarrh (p. 214), in which the lining membrane of the bladder becomes congested and swollen and pours out mucus. Breaches in the mucous membrane may occur, leading to ulceration, blood may escape from congested vessels, and abscesses in the walls may be produced. Irritation of the bladder from the presence of stone, or from the retention of urine, occasions it. The irritation is sometimes due to substances in the blood. Thus poisoning by cantharides, the material of which fly blisters are made, occasions a very painful inflammation; and this may result from absorption from a fly blister placed on some part of the body. Extension of inflammation, such as that of gonorrhœa, excessive drinking, and exposure to cold, are other causes. The disease may be acute or chronic.

The **symptoms** are frequent passing of water, or constant desire to pass it, not much being expelled at a time, the act being accompanied by tenderness or burning pain. There is also tenderness or pain over the region of the bladder in the lower part of the belly, or in the groins, and in the region of the fundament. Fever may be present. The urine is cloudy with mucus, or contains it in quantity, and blood may be mingled with it and much pus, which forms a heavy dirty-white sediment. In chronic forms the symptoms are less marked, but the urine is more altered and may be offensive to the smell.

Treatment.—Hot fomentations should be applied to the lower part of the belly or between the legs. Warm baths are useful. The bowels should be freely opened by a dose of calomel followed by castor-oil, or by a warm injection. If the pain is severe, 10 to 15 drops of laudanum may be given, at intervals of 2 or 3 hours, to be stopped when the pain is relieved. Plenty of watery drinks should be allowed, barley-water, linseed-tea, &c. The patient should be kept at rest, and only mild diet without stimulants allowed. Should the inflammation be due to the presence of stone or other irritant its removal is, first of all, necessary. In chronic cases it is important that the bladder be thoroughly emptied, and for this purpose the use of the catheter (see APPLIANCES FOR THE SICK-ROOM, Plate XXXVIII.) is often necessary. Baths or hot fomentations are useful for relieving pain. The medicines mostly used are infusion of the leaves of buchu, of red bearberry (*uva ursi*), of pareira brava, or of the root of dog's grass (*Triticum repens*). These infusions are made as one makes tea, 1 or 2 ounces of the leaves or root being used to 1 pint of boiling water. The dose is 1 to 4 ounces of the liquid three times daily. The freshly-prepared infusion is best; but fluid extracts may be obtained from chemists, of which one teaspoonful in water is a dose.

Two comparatively recent drugs are extremely useful in such conditions of the bladder, namely urotropin and helmitol. They may be given, one or other, in 10-grain doses in a tumbler of hot water thrice daily, till the urine becomes clear and free from deposit.

If these measures fail to relieve, the bladder should be washed out at regular intervals with antiseptic solutions. This a patient may be taught to do for himself.

Irritability of the bladder is indicated by frequent desire to pass water, the frequency not being due to an excessive quantity of water requiring to be voided. It is often due to excessive acidity of the urine, to irritation in the bowels, such as piles may induce, or in neighbouring organs, in women to irritation of the womb, in children to the irritation of worms. The irritation may be in the prostate gland at the neck of the bladder. Mere nervousness may occasion it.

Treatment.—The cause of any irritation should be sought for and removed, if possible. Excessively acid urine may be corrected by alkaline remedies such as citrate of potash (20 grains in water), excessively alkaline urine by 10 drops dilute hydrochloric acid in water, the doses being repeated several times daily as required. Belladonna ($\frac{1}{4}$ grain of the extract in pill) is useful, specially in nervous cases. If the person is in weak health quinine and iron tonics are called for. Plain diet is necessary, and all excesses should be avoided. Regularity of the bowels is of great consequence.

Paralysis of the bladder may be the result of injury or disease of the spine, or of parts in the neighbourhood of the bladder. Over-distention of the bladder often leads to inability to empty it properly. As a result either the urine is retained in the bladder or it constantly dribbles away. In such cases the catheter must be passed (see APPLIANCES FOR THE SICK-ROOM, Plate XXXVIII., Vol. II.).

Retention and Incontinence of urine.—In *retention* the bladder is constantly full and the patient cannot empty it. It is, however, commonly accompanied by constant dribbling of urine, so that the person thinks his bladder cannot hold the urine. He imagines his bladder is empty, whereas it is simply the overflow, the quantity that cannot find accommodation in the already over-distended bladder, that escapes. True *incontinence* is present when the bladder can retain no urine, and such cases are rare, occurring only in paralysis. As a rule in so-called incontinence, affecting usually men advanced in years, the bladder is over-full, being unable to empty itself, and only the overflow dribbles away. In the lower part of the belly the distended bladder may be felt as a tumour, and uneasiness is experienced there.

The **treatment** consists in passing the catheter and withdrawing the urine; and this requires to be done regularly till the bladder recovers its tone. Retention sometimes occurs suddenly—for example, to men on a journey who cannot get an opportunity to empty the bladder, and who, when the opportunity occurs, find they cannot then make water in spite of effort. Sometimes in such cases a hot hip-bath relieves.

Incontinence of urine in children is spoken of in the section devoted to DISEASES OF CHILDREN.

Stone in the bladder.—The causes of the formation of stone have been considered at p. 402.

Its **symptoms** are irritability of the bladder, frequent desire to pass water, and symptoms of chronic inflammation. There is pain occasionally at the neck of the bladder or point of the penis, aggravated by jolting exercise. The stream of urine is sometimes suddenly arrested by the stone falling over the opening from the bladder, and on the person changing his position it flows again. Blood frequently occurs in the urine. Stone cannot, however, be absolutely said to be present till a surgeon has detected it with a sounding instrument.

Treatment consists in crushing the stone by means of an instrument passed up the passage into the bladder, and allowing the fragments to be washed away in the urine. Such an operation is called lithotrity. The stone may be removed entire by means of an opening made into the bladder, through which the stone is drawn by forceps. This operation is called "cutting for stone" or lithotomy. Relief from some of the symptoms may be had by such measures as are recommended for inflammation of the bladder (p. 410).

Tumours of various kinds, cancerous and others, may occur in the bladder, and lead to symptoms of chronic inflammation, sometimes to serious loss of blood.

Disease of the Prostate Gland is common after middle life. As stated (p. 398) this is a structure which surrounds the urinary canal where it connects with the bladder, and is present only in the male sex. After middle life the gland tends to enlarge, and if the enlargement be not uniform but irregular, the shape of the urinary canal may be seriously altered, made exceedingly tortuous, or reduced to a slit. A consequence of such a condition is a gradually increasing difficulty in emptying the bladder, the stream is slow and without force though full. As the bladder loses tone it fails to empty itself, and if it is never properly emptied the desire to pass water becomes more frequent. This is specially noticeable at night, and in bed, until the patient may have to rise every hour.

Another consequence of the urine being retained is that the bladder becomes irritated, large deposits of mucus occur in the urine, which may also undergo decomposition in the bladder and become foul-smelling. Blood may be passed. If so it is usually at the beginning of urination, and it may be in clots, the more or less clear urine following.

If the early symptoms of this condition be attended to, a patient may take such precautions as will probably save him from the necessity of serious surgical treatment. These precautions are: avoidance of chills, great temperance in eating and drinking, light, easily digested food in moderate quantity only being taken, alcohol and malt liquors being avoided, regulation of the bowels, and the establishment of a habit of emptying the bladder at regular intervals. As soon as the patient begins to be disturbed several times at night, the question should be considered whether he should not be taught to completely empty the bladder by means of an instrument each night. But this is a question for a doctor to settle.

SECTION XX.

THE SKIN, HAIR, AND NAILS.

THEIR STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Skin:
Its structure—Dermis and Epidermis;
Sweat glands;
Hair and Nail;
Glands (Sebaceous) *of the hair;*
Functions of the Skin—protection—excretion—the nature of sweat—regulation of temperature—absorption.

The skin occupies an important position as an organ of the body. It is a blood-purifying organ in as true a sense as the lungs or kidneys are, while it also performs other very important duties. It is not, therefore, merely a protective organ as is too generally supposed. It does form an external covering for the deeper tissues over the whole body, and that its protection is very necessary and efficient everyone knows who has experienced the pain produced by the contact of almost anything with a part of the body from which the top skin has been removed; but in some respects this is the least valuable, though the most apparent, of the functions it discharges.

THE STRUCTURE OF THE SKIN.

The skin consists of a deep layer called the **dermis, corium,** or **true skin** (*cutis vera*), and of a superficial layer—the **epidermis** (Greek, *epi*, upon, and *derma*, the skin), **cuticle,** or **scarf skin** (*a*, Fig. 164). The true skin consists of fibrous tissue, the bundles of which form a felted interlacement. It lies upon a bed of fatty tissue (*c′ d*, Fig. 164) which fills up the inequalities of the surface on which the skin rests. Groups of the fat cells of this tissue also abound in the deepest layers of the true skin. Pervading the fibrous tissue is also an abundance of fibres of the elastic sort (p. 56) which confer elasticity on the skin. The true skin (*b–e*) is very vascular, that is, is richly supplied with blood-vessels, so that when cut it bleeds; and nerve fibres are likewise disposed in it, conferring sensibility. The surface of the true skin is thrown into a series of elevations, papillæ, or finger-like prominences (*b*, Fig. 164) which are specially rich in capillary blood-vessels and nerve-endings, and which are thus particularly vascular and sensitive. Above the true skin is the scarf skin, the projections of the former fitting into excavations in the latter. The epidermis, however, is composed entirely of cells, and is quite devoid of blood-vessels or nerves, so that it may be cut without bleeding or pain. There are several layers of cells, and the shape of the cells alters from the deep parts upwards. The cells directly lining the surface of the true skin and the papillae are columnar and nucleated. They are soft and active cells, and clothing the papillæ are several layers of them. In the layers nearer the surface the cells lose their columnar shape and become more flattened. They also gradually become less soft and more horny, until towards the surface they are flattened and scale-like. The surface scales are continually being thrown or rubbed off, and their places are supplied by deeper cells which reach the surface by growth from below. New cells are continually being produced in the deep layer in contact with the true skin; and as they are formed they push upwards the already existing cells. So that cells originally active and columnar gradually pass upwards, becoming horny, till they are finally cast off. The fine white dust that one may scrape off the skin consists of these horny scales.

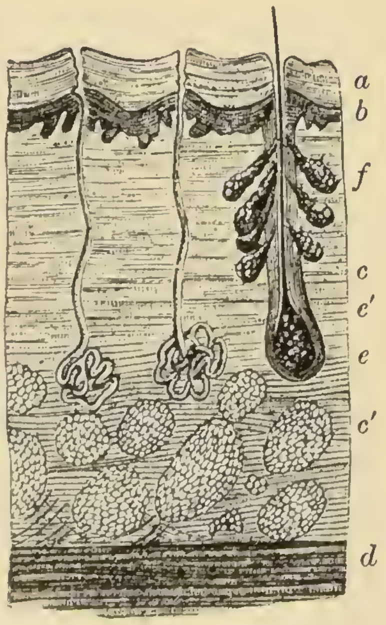


Fig. 164.—The Structure of the Skin.

It is in the deep and active layers, called the **rete mucosum,** of the epidermis that colouring matters are present, which give the hue to the skin. For example, in dark races black pigment is present in these cells. The epidermis is thickest over the parts exposed to greatest pressure or friction, securing protection to the sensitive true skin below.

At the openings of the body the skin passes into mucous membrane, the structure of the two being practically identical, the difference being merely in the thinness of the epidermal covering of the mucous membrane and the increased supply of blood to the membrane.

Glands of the Skin.—The special glands of the skin are the **sudoriparous** (*e*, Fig. 164) or **sweat glands** (Latin, *sudor*, sweat, and *pario*, to bring forth). They are tubular glands. Deep in the substance of the true skin, or in the fatty tissue beneath it, the tube is coiled up into a sort of ball. From the coil the tube passes upwards through the true skin, following a wavy course, till it reaches the epidermis, which it penetrates in a spiral manner till it opens on the surface. Two of such glands are shown in Fig. 164 (*e e'*). The tubes consist of delicate membranous walls lined within by cells. The coiled part of the gland is surrounded by a dense net-work of fine blood-vessels, and thus the cells of the gland are separated from the blood by only a very fine membranous partition, and can draw from it what supplies they need for their particular work.

It is estimated that the total number of sweat glands in the human skin is over two millions. They are not, however, equally distributed over the body. They are fewest in the back and neck, where it is estimated there are on an average 400 to the square inch. They are in greatest number in the skin of the palm of the hand, where they amount to nearly 3000 in each square inch; according to Erasmus Wilson, 3528. Their openings occur on the ridges into which the skin is there thrown, and may be made out by a hand lens. Next to the palm of the hand they occur in greatest number in the sole of the foot, next on the back of the hand and foot, and the smallest number is that already noted in the skin of the back. The length of a tube, when fully straightened out, is about $\frac{1}{4}$ inch; so that, according to Sir E. Wilson, in 1 square inch of skin from the palm of the hand there is a length of sweat tube equal to $73\frac{1}{2}$ feet. If we estimate the number of glands in the body to be between two and three millions, the total length of tube devoted to the secretion of sweat would be about *10 miles*. According to Erasmus Wilson's estimate it amounts to even *28 miles*.

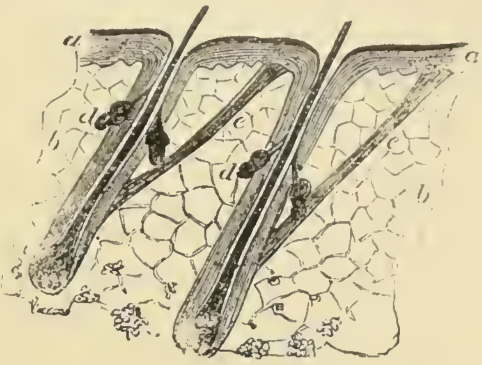


Fig. 165.—Hair, Hair Follicles and Glands.

a, epidermis; *b*, true skin; *c*, hair bulb; *d*, sebaceous glands; *e*, muscle and hair sac.

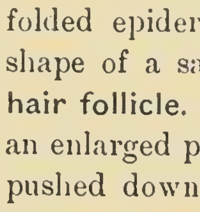


Fig. 166.

Hair.—Hairs and nails are originally derived from the epidermis, and are essentially cellular structures. A hair is formed by a folding or dipping inwards of the skin. A depression or furrow is thus formed, the inner walls of the depression consisting of the infolded epidermis. The depression takes the shape of a sac, and is called the **hair sac** or **hair follicle**. At the bottom of the follicle is an enlarged papilla of the true skin (*c*, Fig. 165) pushed downwards by the folding-in process. Like the other papillæ of the skin, it is covered with the active cells of the deep layer of the epidermis, which form a bulbous enlargement over the papilla, that is, the root of the hair. As the cells in direct contact with the papilla grow and multiply, those above them are pushed upwards to make room for them, and owing to the shape of the hair sac the cells become packed together so as to form a cylinder or stem, which finally, as the growth from below goes on, is pushed out beyond the skin as the shaft of the hair. A hair thus consists of a peculiar arrangement of the cells covering the true skin. So closely are the cells packed to form the cylinder that a fibrous appearance is presented, except in the centre of the hair—the medulla—where the cells still retain their shape, and make the hair appear different in the centre from the circumference. The hair is thus *not a tube but a solid rod* composed of cells packed tightly at the circumference and loosely in the centre. Sometimes little spaces exist in the centre owing to absorption of cells, and the spaces are filled with air, giving in some parts the appearance of a tube when the hair is examined under the microscope. The different colour of hair is due to pigment present in the cementing substance between the cells as well as in the cells themselves.

Fig. 166 shows the appearance under the microscope of a hair, the cells overlapping one another like tiles on a roof.

Glands of Hair.—Opening off from each hair sac are one or two glands (*f*, Fig. 164), the **sebaceous** glands (Latin, *sebum*, tallow). They are also shown in Fig. 165, *d*, and consist of groups of minute sacs lined with cells, which produce an oily material to lubricate the hair and skin. Connected with each hair sac, especially if of a good size, is a bundle of involuntary muscular fibres (*e*, Fig. 165). The bundle passes in such a direction that, when it contracts, the hair sac, which is placed obliquely in the skin, is caused to become more upright, and thus the hair is made "to stand on end." It is this that causes the appearance of "goose's skin."

A **Nail** is also a compact mass of epidermal cells. At the bottom of a fold on the skin is the root of the nail, at which growth takes place by multiplication of cells. The nail is thus continually pushed forward by the growth behind. The bed on which the nail rests, and from which it also receives additions, is formed by numerous papillæ of the true skin.

Just as in man hair and nails are altered epidermal structures, so the feathers of birds and the claws of animals are formed from the surface layers of the skin.

Finger-Prints.—The ridges and furrows caused by the true skin being thrown into the papillæ described on p. 412, are not obliterated by the layers of cuticle above them. On the contrary the cuticle is moulded, so to speak, accurately over the elevations and depressions of the true skin. The surface of the skin is not therefore smooth, but irregularly marked. On most of the body the furrows are shallow and irregular, and intersect one another; but on the palm of the hand and sole of the foot they form more or less parallel lines and curves, producing well-marked patterns. It has been shown that these patterns, specially well seen on the tips of the fingers and front of the thumb, are different in different individuals, no two persons having identically the same arrangement of curves. It has also been proved that the arrangement never changes throughout life, unless by injury of the skin, and that the pattern on the infant's thumb is the same as the pattern will be when the infant has become an old man. An impression of the marks, therefore, on a person's thumb, taken on wax or in ink, will serve as a means of identifying the same person years after. Similarly the marks of greasy fingers, left on a polished surface, such as glass or silver, can be used as a means of identifying the person. This method of identifying criminals has been adopted in Great Britain, since 1902 an impression of the finger-prints of every criminal being taken and carefully classified and preserved.

THE FUNCTIONS OF THE SKIN.

Manifestly the skin *covers in and protects* the more delicate structures that lie beneath it. This it does by means of the horny and insensitive epidermis; for everyone knows that if an injury tears off the cuticle the uncovered true skin is keenly sensitive to the slightest contact with any foreign body, and to heat and cold. The epidermis also protects from the absorption of poisons, for one may handle with impunity, when the skin is whole, substances which, gaining access by the smallest wound, might cause serious injury. The skin, however, ranks as *an excretory organ* of importance. Its excretion is called sweat, and is the product of the sudoriparous glands. In addition, the sebaceous glands secrete an oily fluid useful for lubrication.

The sweat or perspiration is a colourless transparent fluid, consisting chiefly of water, but containing a small quantity of saline material and traces of urea, and being of acid reaction. In some parts of the body, and especially in the arm-pits, the glands secrete a substance having a peculiar smell. It would seem also that some carbonic acid gas passes off by the skin, but not more than $\frac{1}{50}$th of what escapes by the lungs. In ordinary circumstances the sweat passes off from the skin as vapour as fast as it reaches the surface. One would readily conclude, therefore, that usually the skin is not active. This is not so. On an average the quantity of water that escapes from the skin as vapour is about 2 lbs. daily. If strong exercise be engaged in, or if the body be exposed to great external warmth, particularly when the external air is moist, the sweat becomes more abundant, and, unable to pass off quickly enough, collects on the surface in drops. A distinction is, therefore, drawn between **insensible perspiration**, the perspiration that passes from the skin unseen as vapour, and **sensible perspiration**, the sweat that collects on the surface. The distinction is worth noticing, since water is continually being lost from the surface of the body, though at times it is quite apparent, and at other times not so. A man's weight may be reduced several pounds in an hour by loss through perspiration alone. To some extent this may explain the weakening effect produced by excessive sweating in the course of some diseases, for example the night-sweats of consumption.

It is in the coiled part of the sudoriparous gland that the sweat is produced. The blood that surrounds the coil in capillary vessels is in intimate connection with the cells of the gland, and it is from the blood that the cells separate the materials that form the perspiration. It is thus apparent that the greater the quantity of blood flowing to the skin the more sweat is likely to be formed. The blood-vessels of the skin, like the blood-vessels of other parts of the body, are under the control of the nervous system, by which their width is regulated. If the nervous control is removed the blood-vessels widen, more blood flows through them, and more raw material is brought to the glands. In other ways the blood-vessels may become more fully charged with blood than usual. External warmth relaxes the skin and the vessels; there is thus a determination of blood to the skin and increased perspiration. On the other hand, external cold causes the skin and vessels to contract, diminishes the supply of blood, and lessens the amount of sweat. By such a process as this the skin is able to discharge a third function, that of **regulating the temperature of the body**.

The transition of a liquid to the state of vapour is always accompanied by a loss of heat. Heat is necessary, that is to say, to convert a liquid into a vapour. Any liquid that very quickly evaporates produces, when placed on the skin, a marked sense of coldness, because the heat necessary to transform the liquid into vapour has been drawn from the skin, and withdrawn quickly. Even so, every particle of sweat that reaches the mouth of a sweat gland and passes off into the air carries with it a certain quantity of heat from the body, and cools the body by that amount. It is this that makes one so readily feel chilly after excessive sweating, the evaporation of a large quantity of sweat rapidly cooling the surface. Now, if the atmosphere be very warm, a greater quantity of sweat will be produced, as we have seen, and its evaporation will tend to prevent the heat of the body rising. Whereas, if the atmosphere is cold, much less sweat is produced, and the loss of heat from the body is greatly lessened, and its temperature prevented from falling. Thus the skin greatly aids in maintaining an average heat of the body, and in preventing rises and falls of its temperature with every variation of the external atmosphere.

It would seem also as if the nervous system had some direct action on the sweat glands. Fear or other strong emotion often causes sweat to break over the skin even while the surface is very pale and the quantity of blood diminished. Cold sweats are frequent in the extreme depression that precedes some forms of sickness or fainting. It is probable that such outbursts of sweat are due to some nervous influence accompanying the general condition and acting directly on the sweat glands.

Many drugs influence the process of sweating either by increasing the amount or by diminishing it. Thus opium causes profuse sweating, while atropine, the active principle of belladonna, is capable of completely arresting it.

The reason for giving medicines to excite sweating during the course of some fevers is plain. By promoting the activity of the skin they tend to reduce the heat, and, moreover, by increasing the quantity of material separated from the blood they widen a channel by which unhealthy stuff that may exist in the blood and be the cause of the disturbance may be swept out.

Some relationship exists between the skin and kidneys. In cold weather, when the skin is less active, a large quantity of water is passed off by the kidneys, while in warm weather, or under circumstances producing great activity of the skin, the quantity of water separated by the kidneys is proportionately diminished. This is a point of great importance. It indicates that, when disease of the kidneys is present, these organs may be relieved to a considerable extent and their labour lessened by any means which excite perspiration.

If the skin be covered over by varnish, so that its functions are completely arrested, death speedily results. The reason is not known, though many explanations of the circumstance have been offered. After varnishing, the bodily heat falls very rapidly, due, it has been said, to the blood-vessels of the skin becoming very wide, permitting a large flow of blood to the surface and rapid cooling in consequence. In animals that have been varnished death has been delayed for a considerable time by wrapping them in cotton-wool, and thus hindering the great loss of heat, or by placing them in some warm place to maintain the temperature. This, however, does not seem to explain all the effects of varnishing the skin. Symptoms of blood poisoning arise, and albumin appears in the urine, in fact symptoms similar to those of uræmic poisoning, which is described on p. 400. The retention of poisonous matters in the blood, owing to the activity of the skin being set aside, would explain such symptoms. Some confirmation of this view is afforded by the statement of a German observer that the injection of filtered sweat caused fever and albumin in the urine.

Tarring and feathering, the punishment of mob-law in some parts of America, have effects similar to those of varnishing the skin, and cause a painful death after some time. The hot tar, poured over the body, so enters and closes up the pores of the skin that it is practically an impossibility to remove it. The effort to wash off the tar by scrubbing, &c., is attended by extreme pain, because the fine hairs all over the body become so embedded in the tar that they are pulled out in the process. Probably the best method to remove it would be to seat the person in a bath of turpentine, if such could be obtained, and to rub only with the hands. If, in such a case, patches of the skin could be cleaned here and there, so that their activity could be restored, these patches would sufficiently discharge the functions of the skin to avert a fatal result. For this purpose turpentine or benzine would be the best agent to employ.

Finally, the skin seems capable of absorbing matters to which it is freely exposed, and of passing them onwards into the blood. Fluids in contact with the skin, and solid substances rubbed into it, may be absorbed. Thus cases are on record where persons have gained weight by exposure to a moist atmosphere, or by immersion in a bath. Sailors, deprived of fresh water, have been able to allay their thirst by wearing their clothes soaked in salt water. Mercury and other ointments rubbed into the skin are capable of acting on the system, apparently because particles gain entrance to the lymphatics. The extent to which absorption occurs through the sound skin, however, is not great. Even where vigorous rubbing is performed to force the particles into the mouths of the glands the absorption is limited. But from parts where the scarf-skin has been removed, various substances may be picked up and passed rapidly into the blood. Sometimes, therefore, where it is thought desirable to act through the skin, a small blister is applied, and the substance—morphia powder, for example, dusted over the raw surface.

The part played by the skin in touch will be considered in the section on the organs of sense (p. 443).

These considerations as to the functions of the skin ought to render it apparent that the skin is a very important organ of the body. It is not, however, generally viewed in this light. At least it very often does not receive the care and attention which, as such, it deserves. It will be apparent that the minute openings of the sweat glands—the pores of the skin as they are called—may be easily blocked by worn-out cells of the cuticle or by materials deposited by the drying of the sweat, and that, to keep the skin free and active, constant cleansing is necessary. If systematic cleansing of the surface of the body is not practised, not only will the skin fail to separate from the blood the waste products it ought to expel from the body, but more labour will be thrown on other organs, and specially, as noted above, on the kidneys, to counteract its inefficiency. Thus uncleanliness may not only cause disease in the skin, as will be seen in the next part of this section, but may help to excite disease in other parts.

SECTION XXI.

THE SKIN, HAIR, AND NAILS.

THEIR DISEASES AND INJURIES.

Eruptions of the Skin:

- The *pimple* (papule), *vesicle*, *pustule*, *bleb* (bulla), *tubercle*, *wheal*, *tumour*, and *stain* (macule);
- The *excoriation*, *crust*, *crack*, and *scar* (cicatrix);
- *Desquamation.*

Inflammatory Affections of the Skin:

- *Inflammatory Blush* (*Erythema*)—Erythema nodosum;
- *Rose-rash* (*Roseola—False Measles*);
- *Nettle-rash* (*Urticaria*);
- *Erysipelas* (*The Rose—St. Anthony's Fire*);
- *Boil* (*Furunculus*) and *Carbuncle* (*Anthrax*);
- *Ulcers;*
- *Herpes*—Herpes of the Lip;
- *Shingles* (*Herpes Zoster*);
- *Pemphigus;*
- *Eczema* (*Moist Tetter*);
- *Psoriasis* (*Dry Tetter*);
- *Dandruff* (*Branny Tetter—Pityriasis*);
- *Impetigo* (*Pustular Tetter—Honey Scab*);
- *Lichen*—Strophulus—Red Gum Rash.

Overgrowths, New Growths, and Hæmorrhages of the Skin:

- *Barbados Leg* (*Elephantiasis Arabum*);
- *Fish-skin Disease* (*Ichthyosis*);
- *Leprosy* (*Lepra—Elephantiasis Græcorum*);
- *Lupus;*
- *Freckles; Corns; Warts; Horns; Moles* (*Mother's Mark—Nævi*);
- *Purpura Hæmorrhagica;*
- *Cancer and Epithelioma.*

Itching Diseases and Diseases due to Insects:

- *Itching* (*Pruritus*);
- *The Itch* (*Scabies*);
- *Lousiness* (*Phthiriasis—Pediculosis*);
- *Eruptions due to Fleas, Bugs, Gnats, Mosquitoes;*
- *Ringworm* (*Tinea Tonsuranos*);
- *Favus* (*Honeycomb Ringworm*);
- *Pityriasis Versicolor.*

Affections of the Glands of the Skin:

- *Excessive secretion of sebaceous glands* (*Seborrhœa*);
- *Comedones* (*Shilfcorns, Grub*); *Milia; Wens; Molluscum;*
- *Excessive or altered secretion of sweat*—Stinking Sweat;
- *Miliaria* (*Sudamina*)—Prickly Heat;
- *Acne* (*Face Pimples*)—Acne of the Beard; *Acne Rosacea.*

Injuries to the Skin:

- *Wounds; Burns; Chilblains and Frostbite.*

Affections of the Hair and Nails:

- *Excess of Hair* (*Hirsuties*); *Hairy Mole;*
- *Baldness* (*Alopecia*) and *Grayness of Hair* (*Canities*);
- *Inflammation of Nails* (*Onychia*);
- *Excessive Growth of Nail*—Ingrowing Nail.

The Care of the Skin, Hair and Nails.

The diseases of the skin are numerous, and many of them are troublesome. The structure of the skin, as indicated in Section XX, is comparatively complicated. The true skin itself is supplied with blood-vessels and nerves, and is therefore liable to various forms of inflammatory change to which any other structure rich in vessels and nerves is exposed. But there are also to be taken into account the sweat glands and canals that are imbedded in and pass through it, and the appendages that belong to it, in the shape of hairs and nails with their attendant glands, all of them liable in themselves to various departures from a healthy condition. Moreover, the skin ranks as a blood-purifying organ in as true a sense as the lungs or the kidneys, though in a less degree, and it may thus be not only the seat of a disease which affects it exclusively, but may likewise be a sharer in an unhealthy condition that disturbs more or less generally the rest of the body. A disease of the skin may be, that is to say, a mere local disturbance, an affection limited to the part where it is manifested, or it may be the indication and result of a general condition of body. Thus the eruptions, or rashes, that attend many special fevers, such as scarlet fever, measles, typhus, and typhoid fever, &c., are evidently mere occurrences in the course of a disease affecting the whole body. No one would think of treating these eruptions by themselves, for they will gradually disappear as soon as the constitutional disturbance, in whose train they come, has passed away. But there are other eruptions, as well as affections of the skin not attended by any rash, as truly produced by a general disorder, not to be got rid of till the general disorder has been set right, that are not so readily traced to their true cause. Here, however, an error must be guarded against. It is a common belief that many skin diseases are peculiarly the expression of a "vice of blood," which is seeking an outlet in this way, and that, if this way of escape is denied to it, it will, in revenge, as it were, attack deeper and more vital parts. The common conclusion, accordingly, is that the disease ought to be permitted to run riot through the skin, if it pleases, lest attempts to cure it drive it inwards. Now we have seen (p. 414) that the skin is a blood-purifying organ, that by means of its glands it separates from the blood and casts out of the body certain impurities. It is also true that in fevers, accompanied by rash, such as measles, scarlet fever, &c., the treatment consists in the use of warm baths or hot packs, and in the administration of medicines which, besides relieving the bowels, "determine to the skin and kidneys," as the phrase is, that is, stimulate the activity of skin and kidneys to be more vigorous in their work of purifying the blood, to aid in "throwing off" the disease, or at least in abating its severity. As a sign that this is being done, so far as the skin is concerned, one is accustomed to view with satisfaction a rapid and full development of the rash characteristic of the disease. While this is all true, it is a totally wrong view of the facts that encourages the idea that a cure of any skin eruption runs the risk of creating disease elsewhere. It never is so. Many skin diseases are entirely local, are due, that is to say, to disturbances limited to the part affected, the cure of which implies that the disturbances have been got rid of. In those cases where the skin eruption is only a symptom of a constitutional disease, the cure of the eruption is always to be regarded as a sign that the constitutional defect is being remedied. In all cases, consequently, skin diseases should be submitted to treatment; and that treatment is the best which most rapidly and thoroughly restores the skin to its healthy condition.

In this section the eruptions of the skin that attend the acute fevers are not considered, but are discussed in the section on acute fevers. Apart from these the various affections of the skin are reviewed in this section, and are classed under different headings. Various classifications have been proposed by different authorities, none of which is employed here, the arrangement used being dictated simply by convenience. Inflammatory affections of the skin are first discussed, then growths and tumours, itching and parasitic diseases, affections of the sweat glands, affections of the hair and sebaceous glands, and affections of the nails.

First, however, as a great many skin diseases are attended by visible alterations in the surface, discoloration, or elevations of the surface in the form of eruption, &c., and since the nature of such change is some guide to the character of the disease, it will be well to explain the terms employed to distinguish between various forms of such alteration.

VARIOUS FORMS OF ERUPTION (RASH), &c., OF THE SKIN.

The pimple or papule is a solid elevation above the level of the skin, between a millet seed and a lentil in size. It apparently contains no fluid. It may be of the colour of the natural skin, reddish, bluish, or black, &c. Pimples are commonly connected with the glands of the hair, due to effusion of material prevented from escaping, or they may be due to inflammatory swelling of the papillæ of the true skin. Their presence gives a feeling of roughness to the skin, and may occasion severe itching and tingling.

The vesicle is an elevation of the upper horny layer of the skin by fluid accumulated between it and the deeper layers. It is of the size of a pimple, and the fluid is clear or milky. The thin covering may burst and the fluid escape, or it may evaporate, or the clear fluid may become yellow and a pustule be formed.

A pustule is the same as a vesicle, but instead of clear fluid it contains yellow matter—pus. A vesicle becomes a pustle if the clear contents of the vesicle alter their character, as they often do.

A bleb or bulla is the same as a vesicle except in size. They may be as large as walnuts, or even hen's eggs, or still larger. The contents of the bleb may, however, be pus.

A tubercle is a solid swelling larger than that to which the term pimple is applied, but of a similar kind.

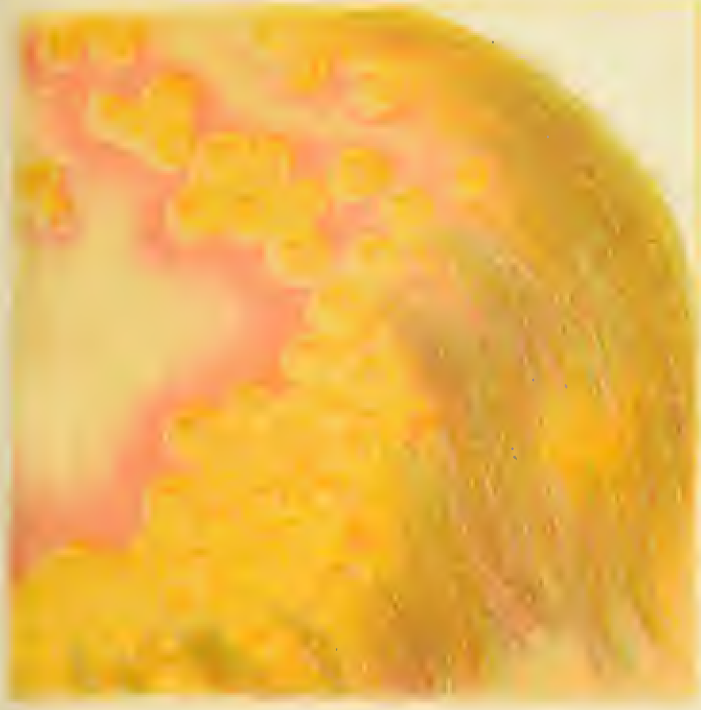
A wheal is the term applied to a raised portion of skin of greater extent than thickness. It may be of varying shades of red, and is generally flat. It is due to swelling in the upper layer of the true skin itself.

A tumour is a solid swelling, in size between a walnut and a man's fist, situated in the deeper layers of the skin.

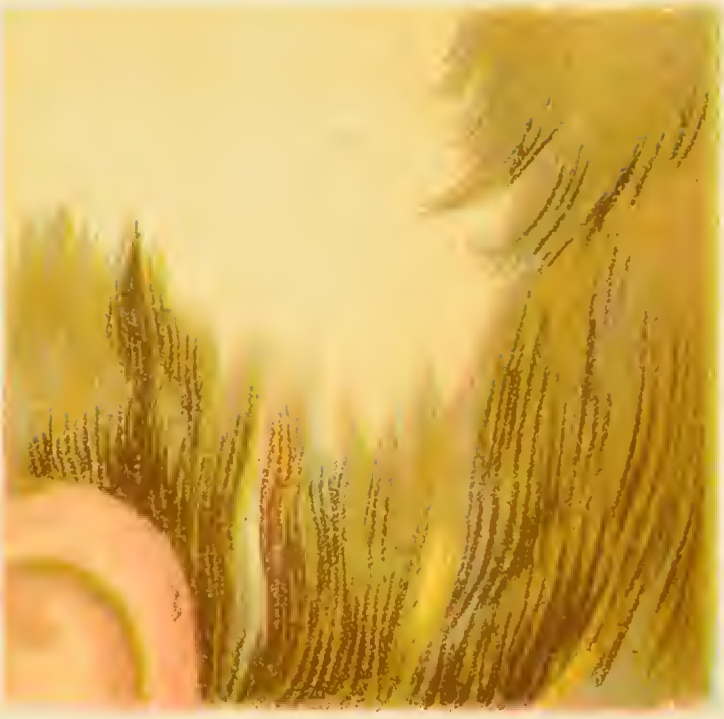
Lastly, there is the **stain** or **macule,** or **spot,** caused by a change in the ordinary colour of the skin. Spots may be of varying colour, white, red, blue, yellow, brown, &c., and of very different sizes. They are not raised above the surface. They may be produced by blood being poured out in the substance of the skin at mere points here and there or in patches.

DISEASES OF THE SKIN.

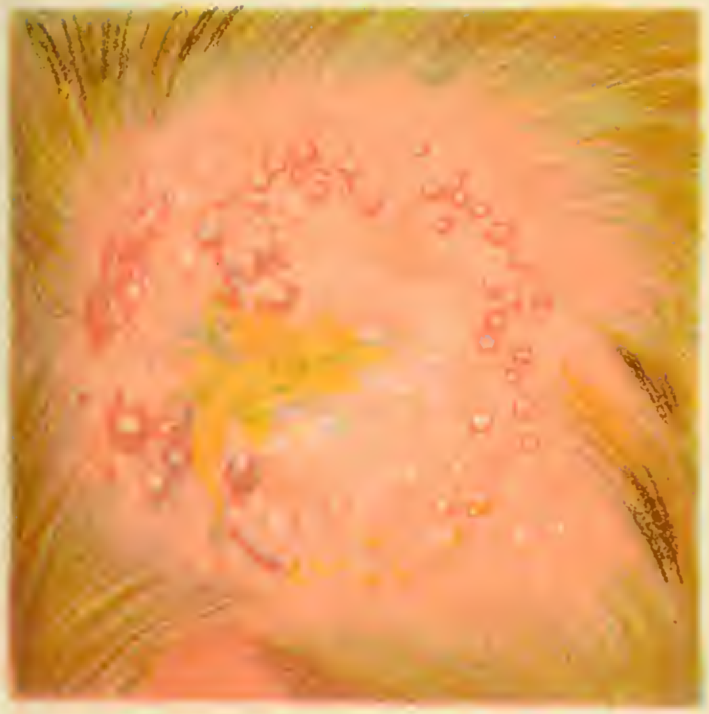
Plate XXIV


Crusted or Honey-comb Ringworm – Favus

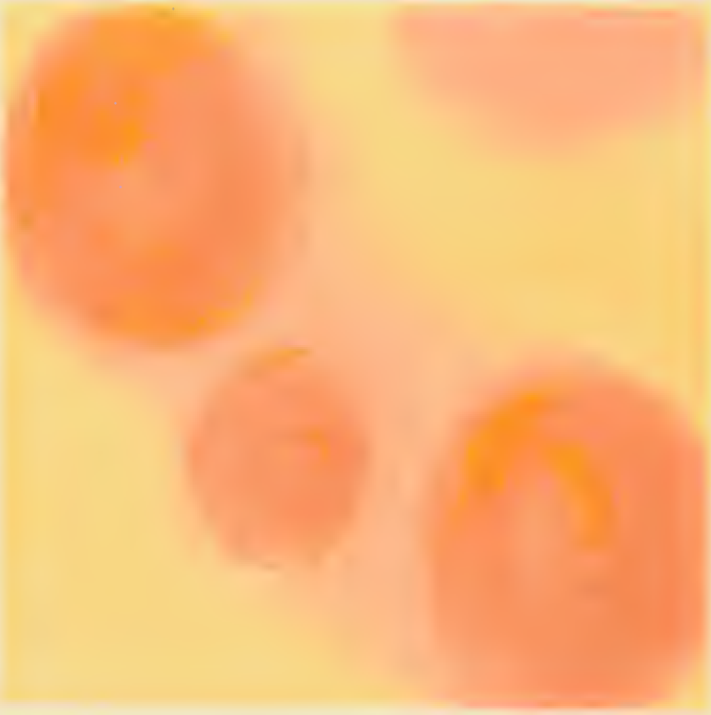
p 434


Bald Spots – Tinea decalvans – Alopecia

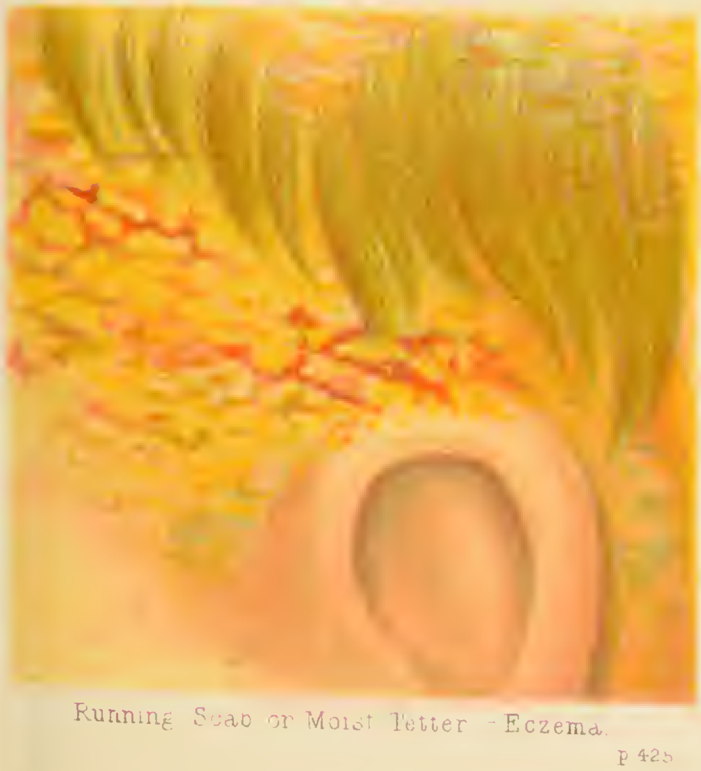
p 437


Ringworm of Scalp – Tinea tonsurans

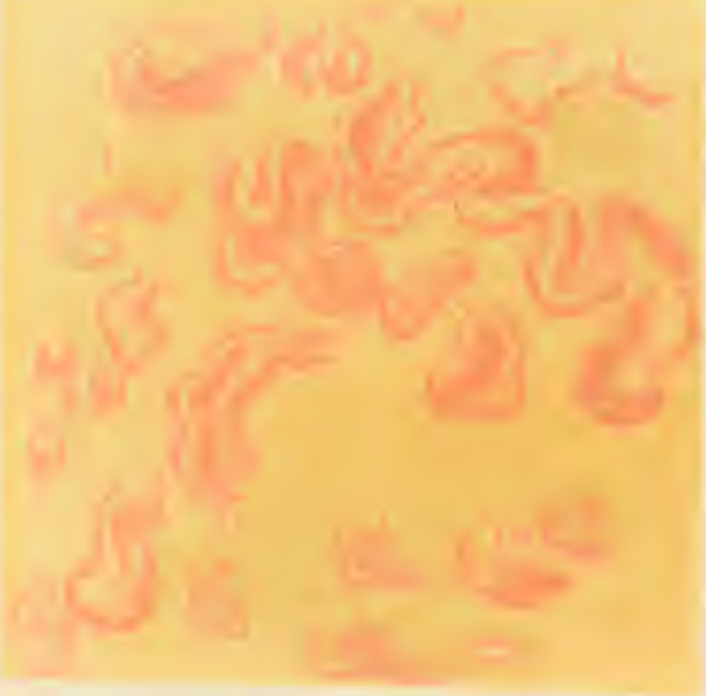
p 434


Erythema nodosum

p 419


Running Scab or Moist Tetter – Eczema.

p 425


Nettle Rash – Urticaria

p 420

The blood spot passes through changes in colour, blue, green, and yellow, before it disappears.

These various forms of eruption are not necessarily separate and distinct kinds; for the pimple may become a vesicle, and the vesicle may change to a pustule, and the condition that produces the pimple will give rise to the tubercle if a larger extent of surface be affected. Similarly the difference between a vesicle and a bleb consists simply in the size of the area affected.

Moreover, scratching, rubbing, &c., effect alterations in the appearance of the eruption. In itchy diseases frequently the original form of the eruption is not recognizable because of the effects of scratching. The heads of pimples may be knocked off so that blood oozes in drops and hardens on the pimple, changing its appearance. The skin covering vesicles, pustules, &c., may be removed by scratching, and raw surfaces remain from which clear fluid, perhaps mixed with blood, oozes. This is called an **excoriation**. Then the fluid dries and leaves the surface covered by a **crust**, which varies in colour, according as only clear serum has been present, or that fluid mixed with blood or yellow discharge.

Cracks or **fissures** are apt to be produced in the skin as a result of dryness or brittleness. The term **scar** or **cicatrix** is applied to the marks left after some loss of substance in the skin. The scar is a lower form of tissue which has been produced to make good the deficiency occasioned by the disease or injury. Thus in a deep wound the cicatrix is due to the new material formed between the lips of the wound to effect their union, and the cicatrix that marks the site where an ulcer has been is formed of new tissue attempting to take the place of that destroyed by the ulcerative process.

Scales are masses of cells from the horny layer of the skin shed as a result of some change in the deeper parts of the skin which has deprived them of nourishment. Thus scales are copiously shed in chronic inflammatory conditions of the skin. In scarlet fever and other acute diseases parts of the horny layer of the skin may separate in large masses. This separation of masses of cells of the epidermis, whether in the form of scales or in larger portions, is called **desquamation**.

INFLAMMATORY AFFECTIONS OF THE SKIN.

Inflammatory Blush (*Erythema*).—This is in the form of patches of a dusky-red colour caused by increased flow of blood through the vessels of the part. Sometimes the patches are slightly raised above the level of the skin. In the simplest form the redness appears suddenly and vanishes suddenly, and is accompanied frequently by some degree of tingling. It occurs mostly on face and neck, arms, and trunk. After the redness has passed, fine scales are separated. This is most often due to some digestive disorder. Another form is caused by rubbing of one surface of the skin upon another, as seen in children, and may lead to chapping of the skin. Frequent bathing is all that is necessary for this, followed by careful drying, and perhaps the use of glycerine or vaseline. In one kind of erythema occurring generally on the backs of the hands and feet, sometimes extending to the arms and legs, and seldom to the face, after the diffused redness has passed, pimples are perceived over the affected patch. They fade in a few days, and are not attended by any special symptoms. The most serious form of the disease is **Erythema nodosum** (see Plate XXIV.), in which dark-red oval swellings, from a half to several inches long, appear in crops over the front of the lower limbs in particular, and other parts of the body. The patches are hot and painful, but *not itchy*. In a few days the red colour becomes livid, and then changes to yellow and green, like an ordinary bruise. Neumann states that children have been brought to him from schools, the teachers of which were accused of having beaten them, whilst really they were suffering from erythema nodosum. Loss of appetite, debility, feverishness, headache, &c., precede and accompany the disorder, which chiefly attacks young persons and females. It usually disappears after a few weeks. Some kinds of inflammatory blush are associated with rheumatism.

Treatment.—All that is chiefly required is attention to the diet and to the condition of the digestive organs. An occasional dose of saline medicine (Eno's fruit salt, citrate of magnesia, &c.), or, to children, fluid magnesia, is useful. To weakly persons acid and bitter tonics may be administered. In females some irregularity of the monthly discharges may be the cause of the trouble.

Rose-rash (*Roseola—False Measles*) is the name given to an eruption in which red patches appear on chest and neck, and sometimes on face and arms. They fade on pressure, but reappear on removing the pressure. Lasting only a few days, they soon fade, and often slight shedding of scales of the skin follows. Before and during the eruption feverishness, headache, and disturbances of digestion occur. The affection is apt to be mistaken for measles or scarlet fever, but it is not contagious. Only rest for a day or two is required in the way of treatment.

Nettle-rash (*Urticaria*, from *urtica*, a nettle). —In this disease the eruption is characterized by wheals, which are at first red and spread, becoming then white in the centre (Plate XXIV.). The development of the wheals is accompanied by itchy stinging sensations, such as the sting of the nettle occasions. Fresh crops sometimes break out at intervals on different parts of the body, though each wheal quickly fades. The chest and back are more commonly attacked than the limbs. The face may be affected. For weeks or months the eruption may go on disappearing from one place only to appear on some other part, although it may last for only a few hours altogether. In some cases fever, shivering, headache, and vomiting attend the outbreak, in others these symptoms are absent. Nettle-rash may be excited by irritation of the skin, by bites of fleas, bugs, &c., by stings of various kinds, or by the application to the skin of substances like turpentine. It often arises from the taking of particular kinds of food, drink, or medicine, such as oysters, lobsters, fish, pork, sausages, cheese, cucumbers, mushrooms, copaiba, turpentine, &c. The presence of worms in the bowels, and in women irregularities of the monthly periods, pregnancy, &c., occasion it. Often no cause can be assigned for the attack. It is not contagious.

Treatment.—The bowels should at first be freely opened and thereafter well regulated. The diet should be carefully scrutinized. It is sometimes necessary to leave one thing out after another in order to discover whether the diet is causing the affection. Nor ought one to overlook the fact that gnats or bugs may be the exciting cause. All external sources of irritation of the skin should be removed, linen or cotton being worn next the skin. The person should be kept cool and be lightly clad. Cold sponging and sponging with vinegar and water relieve the irritation for a time. It is sometimes a very obstinate affection.

In chronic troublesome cases a nightly bath of tepid water containing 2 ounces of potassa sulphurata, to the full bath of 30 gallons of water, is most useful. The patient should be in it for 10 to 15 minutes. The patient should be dried without friction, and then the skin smeared lightly with vaseline containing 2 per cent salicylic acid, or with menthol oil, 60 grains menthol to 6 ounces olive-oil. This bath blackens lead-painted baths and smells offensively, and instead of it a bath containing a washhand-basinful of freshly-made starch to the 30 gallons of water, with 1 pint of vinegar added, may be tried.

Erysipelas (*The Rose—St. Anthony's Fire*) is an inflammation of the skin, and therefore, for convenience sake, it is discussed here. But it is an infectious disease, due to an organism whose growth and spread in the skin causes the disease. The organism is a micrococcus (p. 495). By its growth it produces poisonous substances, which enter the blood, poisoning the blood and nervous system, and producing the fever and delirium so marked in the disease. The organism may enter the body by a wound, in which case the inflammation of the skin begins at the edges of the wound, and thence spreads over the surface, and in such cases it begins on whatever part of the body the wound is situated. But it may begin where there is no obvious wound. In these cases its common seat is on the face and head. But careful search in such cases also will often show that there has been some scratch or abrasion where the disease began as an inflamed spot, or there may be a concealed wound or ulcer, in nose or ear, which has been its starting-point. In infants it may begin at a vaccination mark or at the navel.

Symptoms.—The affected piece of skin is red, shiny, swollen, tense and tender, burning or itching. The patch is at first marked off well from the sound skin, but the inflammation spreads rapidly, the eyelids become swollen and cannot be opened, lips swollen, the ears are disfigured, and the whole countenance altered. The inflammation may rapidly spread up and over the scalp, over the neck, causing the glands to be swollen and tender, and down on to the trunk. The inflamed patch, at first bright red, becomes dark, puffy, and boggy, pitting on pressure. In moderately severe cases blebs form, filled with clear fluid which may become yellow. In severe cases the blebs may contain blood. In a few days the inflammation subsides in one place, other parts going through similar stages, and the affected part may resume its normal appearance, the top skin being first shed in flakes. Sometimes, however, pieces of the skin may slough.

The disease is frequently ushered in by chilliness, which rapidly gives place to high fever, with prostration, headache, sleeplessness, and some wandering, or actual delirium. Often the fever and headache exist for a day or two before the nature of the attack is quite clear. There is often sore throat, there is great aversion to food, thirst, dry-coated brown tongue. Moderately severe cases last about a week, but it may go on for 2 or 3 weeks. Pneumonia may occur as a complication, and evidence of kidney disturbance can usually be found in the urine, in the shape of albumin (p. 406).

Treatment.—The case must be recognized as infectious from the beginning, and the precautions proper to all infectious disease followed. The person who attends the patient should be careful not to carry the disease to others, should be specially scrupulous about washing of hands, and should be careful to see that she has herself no sore or scratch on face or hands. The room should be thoroughly aired, and as bare of furniture and hangings as possible.

The patient's diet should consist of milk and bread, soup and bread, and light milk puddings. The bowels should be freely and regularly moved, apenta or fruit saline being excellent for the purpose. For thirst the imperial drink, or lemon squash, may be given.

If there is severe headache or sleeplessness or delirium, a powder of—

Bromide of potassium	10 grains,
Antipyrin	7 grains,
Citrate of caffein	1 grain,

may be given twice or thrice daily, well diluted with water, the last dose at night.

A great many applications to the inflamed skin have been suggested. The progress of the inflammation may often be arrested by painting the skin with a saturated solution in water of picric acid, if this is done early enough. To do this properly and effectually the affected skin should be thoroughly cleansed of dirt and grease. Tepid water should be used and soft soap. A small flannel bag should be made about 2 inches long and 1 inch broad; this should be filled with soft soap and the open end then sewn tight. Everything should be got ready, and neatly arranged.

1. A washhand - basin with tepid water; dropped in it the bag of soft soap.
2. A second basin with clean tepid water.
3. A small bowl containing about a dozen pieces 2 inch square of absorbent wool, the prepared kind called gamgee, or plain-lint.
4. A cup or wine-glass with a little methylated spirit of wine.
5. A tea-cup with the solution of picric acid, and a camel-hair pencil.

The patient should be laid on the bed in the most convenient position for the nurse, a bath towel under head and shoulders, and clothing slipped down out of the way. The nurse having previously thoroughly washed her own hands, and been girt with an apron, goes over the affected part freely and lightly with the soap-bag and tepid water, specially thoroughly any hairy part involved or near the affected skin; the soapy water is then douched off with the fresh water, and then the skin and hair is carefully dried with the pieces of wool. Each piece, as it is soiled, should be tossed into a bucket ready for the purpose. A piece of wool is then taken, dipped in the spirit, and lightly passed over the skin, the eyes being carefully protected. A dry piece of wool mops off the spirit. Then the picric acid is painted on, a broad line being first painted all round the inflamed part, and fully 1 inch outside of it. The inflamed area within this line is thoroughly painted with the solution, running being prevented by the nurse with a piece of wool in the free hand. If the washing has been properly done, and the spirit dried off properly, the solution should not run, and, quickly drying on, should show by the yellow stain that the solution has been thoroughly applied. Any unstained piece of skin in the marked-off area should be gone over again. The patient should then be tidied, dishes, &c. removed, care being taken immediately to wash all vessels, to burn all pieces of soiled wool, and to put into a wash-tub towels, &c., used in the process. This having been done, an ointment, of which the recipe is given below,[1] should be

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[1] Recipe for the ointment:

Oleate of zinc	½ ounce.
Pure carbolic acid	30 grains.
Ichthyol	60 grains.
Prepared chalk	½ ounce.
Glycerine	¼ ounce.
White vaseline	to 2 ounce. Mix.

smeared thickly all over the affected skin, which should then be lightly covered with a layer of wool, thin or thick according to the outside temperature. If it is winter, the layer should be sufficient to keep the skin comfortably protected from cold; if it is summer, the patient's comfort may require that no wool be applied at all—the ointment being sufficient protection. If it is the face and head that are affected, a large piece of gamgee should be cut to shape of a large mask, with holes for eyes, and one for the mouth and nose. This can be very neatly made by binding with thin tape, and it is secured by tapes. A fresh mask need not be frequently made if the same side be always put next the face. Twice a day the nurse should remove the wool mask, and carefully examine the edges of the yellow stain. If the inflammation is spreading anywhere, it will appear as a pink blush beyond the yellow area. Any such little bit appearing should be washed with soap and water and then spirit, none of the rest of the area being touched, and then the picric solution applied. Over all a fresh layer of the ointment should be daily spread. If this method is properly followed, and careful watch kept, the disease will in a great majority of cases cease, and in four or five days will be quite clearly over. Meanwhile it will take all the nurse's deftness and cleanliness to keep the patient tidy in spite of the greasy application. A piece of jaconet stitched on to the pillow will keep it from being stained. It can be regularly sponged. If the disease has ceased to spread after two or three days, the affected parts may be again cleansed. This can be done with pure vaseline, or with olive-oil containing 30 grains menthol to each 6 ounces. A little of this is poured on to the grease-coated skin, and worked into a lather by the tips of the nurse's fingers, well washed for the purpose in hot water and soap and then dried. A little bit is done at a time, and the lather is wiped off with pieces of gamgee. Bit by bit every particle of the layers of ointment may thus in time be removed, and the skin and hair appear as fresh and clean as if they had been washed. The parts should then be very lightly smeared with the fresh menthol oil. In a few days the yellow-stained cuticle will come off, and the fresh healthy skin appear below unstained.

Tincture of steel—tincture perchloride of iron—should be administered to the patient throughout the illness, 15 drops in a wineglassful of water every two hours from 8 a.m. to 8 p.m. For a long time after the attack the patient should protect the part that has been affected from cold and damp and wind.

Boil (*Furunculus*) is an inflammation of a small part of the true skin, usually beginning in the glands of a hair sac. The inflammatory material poured out causes a hard swelling, which is red, painful, and throbbing. Matter forms and appears at the top of the swelling as a yellow point. The matter bursts through and continues to be discharged through a minute opening for some time. Through the opening there may be seen, deep in the part, a yellow centre or "core." By the time this is loosened and discharged, the swelling and redness are greatly lessened, and the cavity fills up. When all tenderness and swelling have passed away a scar remains to mark the spot. In a "blind boil" the process is the same, but the boil is deeper and slower in reaching the surface.

A boil may be produced by some irritation applied to the part at which it appears. It is due to the operation of a microscopic organism, a staphylococcus (see p. 496) acting on a depressed state of general health.

Treatment.—One may be successful in checking the development of a boil in its early stage, when it is felt as a hard painful spot in the skin, by the application of some soothing substance, such as a paint made of equal parts of glycerine and extracts of opium and belladonna. When the boil is hard and stinging, hot applications are most soothing. To the water there should be added lysol, 15 drops to each tumbler of warm water used.

The most effective remedy is the injection under the skin of a vaccine—anti-staphylococcic. Yeast by the mouth is also very helpful; a teaspoonful of dry brewer's yeast stirred into a tumbler of water and taken in four doses each day. Yeast may also be obtained from the druggist in 5-grain tablets. It often hastens cure, and aids in the removal of pain, to have a surgeon freely open the boil with a lancet. Beside such local treatment the patient's bowels should be relieved by seidlitz-powder or similar medicine, and nourishing food, quinine and iron tonic, &c., should be administered.

Carbuncle (*Anthrax*) is an inflammation of the true skin and tissue beneath it akin to that occurring in boils. It is more extensive than the latter, and instead of one has several cores. Considerable portions of the skin are apt to be destroyed and to separate as sloughs. It is associated with a bad state of general health, from which condition its danger arises, for it may threaten life by exhaustion. It begins as a painful hard swelling, increasing in size and deepening in colour, situated most commonly on the back of the neck. The pain is severe and throbbing, and fever is marked. In a few days several openings are formed on the surface, from which discharge escapes, and through the openings yellow "cores" are seen. The skin becomes undermined, and the openings unite to form a large one, revealing an ashy-gray slough in the deeper parts. As this is discharged a cavity is formed extending some distance under the skin. Often pieces of the skin die and are thrown off, so that a large ragged wound is formed, from whose surface shreddy matter separates. The exhaustion is often great, and extensive parts of the skin are more liable to die because of the general weakness.

Treatment. — Nourishing and stimulating diet is of the utmost consequence. Quinine and acid tonics (see PRESCRIPTIONS) are to be given. The local treatment is similar to that prescribed for boil, specially the lysol fomentations. Carbuncle is frequently fatal from exhaustion or blood-poisoning, and from the first a competent surgeon should have charge of the case.

Ulcers of the skin are common. An ulcer implies that the skin is broken, and that there is loss of substance. Owing to softening and breaking down of the skin an open sore exists. Various circumstances may encourage the formation of an ulcer. Thus some persons may be in such a depressed condition of health that the slightest scratch or bruise will lead to breach of the surface and the formation of an ulcer. Again, while the general health may be of a fair average, some particular part may be subject to influences that readily provoke ulceration. Thus persons who suffer from enlarged (varicose) veins are liable to have ulcers forming on the legs on slight provocation. Owing to the dilated veins the circulation is so sluggish that the nourishment of the skin is impaired, and a scratch or knock or bruise gives rise to a sore difficult to heal. Such ulcers occur often in persons who have to stand most of the day, laundresses, cooks, &c., specially if they are stout of build; and the ulcers are on the legs because these are the lowest parts, from which the return of blood is most impeded.

Ulceration may find its starting-point in a cut, bruise, or wound of any kind.

Ulcers heal by what is called **granulation.** The broken surface is covered over by minute red elevations (the granulations) or hillocks of newly-formed tissue, which readily bleed. From the surface fluid oozes away, consisting partly of a clear fluid (serum) and partly of matter (pus). By the growth of the granulations the loss of substance is gradually made up. Round the edge of the sore there is a slow encroachment of the upper layers of the sound skin, so that the extent of the sore gradually diminishes, and a thin covering of scarf-skin spreads over it. Ultimately the sore is entirely covered over, but retains features distinguishing it from normal skin — its thin covering, not of true skin, and its pale transparent appearance. In medical language a cicatrix or scar remains.

There are various kinds of ulcers. The late Professor Syme of Edinburgh classified them as—1. *Healing ulcers*, 2. *Ulcers failing to heal from excess of action*, 3. *Ulcers failing to heal from defect of action*, and 4. *Ulcers failing to heal from peculiarity of action.* It is often a nice point for a surgeon to decide what kind of ulcer he is dealing with, and what is the appropriate treatment. The probability is that an unskilled person, attempting to cure an ulcer, will only aggravate the sore. Here we shall only try to indicate what such a person may do, in the absence of proper surgical advice, without running such a risk.

1. The **healthy ulcer** is known by the small, firm, red elevations that cover it. They are sensitive when touched and readily bleed. There is a slight discharge of healthy matter. The edges are level with the surface, and a thin blue line indicates the advancing layer of skin.

The **treatment** of this kind of ulcer consists simply in giving it fair-play. Let the part be kept at rest and raised—not hanging. Let the part be cleaned by allowing pure tepid water to flow over it from above, containing a teaspoonful of lysol to every quart. Dry it by mopping it with pieces of perfectly clean absorbent wool (gamgee), and then cover it by a layer of the dry absorbent wool, a gauze bandage retaining the whole. Renew the dressing every second day, washing away, not tearing away, the old one. The person's general health should be maintained.

2. The **ulcer failing to heal from excess of** action has red, swollen, angry-looking edges, uneven surface, and thin offensive discharge, and there is aching or throbbing pain.

Treatment. — Raise the part affected and ensure rest. Let the person's bowels be opened by such medicine as seidlitz-powder, and let attention be given to the patient's health. To the ulcer itself apply the lysol dressing mentioned above, a piece of gamgee, the full thickness of the wool and the size of the ulcer, damp with the lotion, being applied after washing, and covered with oiled silk, overlapping the wool all round. If this is not sufficient, a lotion, made of ½ ounce of solution of acetate of lead and the same quantity of glycerine to 5 or 6 ounces of water, may be applied, on lint covered with oiled silk. When the irritation has passed, the treatment for healthy ulcer is to be adopted. Irritable ulcers in full-blooded people, who live "not wisely but too well," will be greatly helped by the free use of seidlitz-powders, or mineral waters like Hunyadi Janos.

3. **The ulcers failing to heal from defect** of action have flabby, large granulations, to which the term "proud flesh" is applied. The discharge is thin and watery, and the ulcer is painless. In other forms the surface is glazed, no granulations being present, and the edges are raised, hard, and irregular.

Treatment.—Those exhibiting "proud flesh" are best treated by firm pads placed on the surface and kept there by moderately-firm bandaging. Under the pads an astringent dressing may be applied. For that purpose a solution of 2 grains of chloride of zinc in an ounce of water may be used, diluted if found advisable. The same solution is valuable for the glazed ulcers. The patient should have nourishing diet and quinine and iron tonics.

4. **Ulcers failing to heal from peculiarity** of action are of various kinds. They may be due to syphilis, scurvy, scrofula, &c., and as a rule their treatment consists of treatment of the constitutional condition which maintains them, which it is the business of a surgeon to detect. Belonging to this class also are ulcers caused by dilated veins, occurring commonly on the legs. Anything that supports the veins will help the ulcer, notably a well-adjusted elastic stocking.

Ulcers prevented from healing by some constitutional state are often sloughing ulcers, whose edges rapidly break down, are very irregular and undermined. It is to be noted that in the simple suggestions for treatment given here no mention is made of the use of bluestone or caustic. These are sometimes used by surgeons, and if used judiciously may often be of great value, but should never be taken into the hands of anyone else.

It is not to be assumed that one or other of the methods noted will be sure to heal any ulcer. Many ulcers are extremely obstinate, and baffle even skilful surgeons. But what it is desirable to insist on is that, if people must treat ulcers on themselves or others without medical advice, such simple means as are mentioned are the only safe methods. In all cases, if after a few days trial the person fails to produce an improvement in the sore, he should seek advice whenever possible.

Herpes is the name given to an eruption characterized by groups of small sacs (vesicles) filled with a clear fluid. An itching or burning sensation announces the approach of the eruption, and the same sensation accompanies it. The part of the skin attacked is swollen and inflamed before the vesicles form. Two or three days after the eruption is fully formed the clear fluid becomes turbid, and finally dries up into a crust. It lasts not more than 7 or 8 days. The eruption may occur on the lips, on the lining membrane of the mouth and tonsils, and rarely the tongue, and on various other parts of the body. It may occur on the private parts. In all its forms it is accompanied by some slight disturbance of general health, fever, headache, &c.

Perhaps the commonest form is that which occurs on either the upper or lower lip during an ordinary cold, and called **herpes labialis**, herpes of the lip. It is familiarly known to everyone as one of the signs of a cold. When they occur on the throat they form little ulcers by the bursting of the vesicles.

Another form is apt to occur in young people at particular times of the year in the shape of clusters of the small blisters about the elbows and knees and other parts.

Treatment.—Painting the part, when the tingling sensation begins, with tincture of camphor may check the eruption; but once it is formed it should be left alone.

Shingles (*Herpes Zoster*) is an eruption of the same kind as that just described. It is, however, much more extensive, and it attacks in particular certain well-defined parts of the body. It seems to have a nervous origin, for it follows the course of some particular nerve. Thus it is common on one side of the chest, from the middle line of the back round to the middle line in front, but not crossing that line. This is the course of one of the nerves running between the ribs. It may occur on both sides, not by extending itself, but because it attacks two different nerves. This, however, is rare. It may occur over the belly in the same semicircular way, also over the cheeks and nose, or over the forehead from the inner corner of the eyelid, following the line of one of the sensory nerves of the face; and in other localities.

It is preceded by stinging neuralgic pains for 24 or 48 hours, then the eruption comes out in numerous groups (Plate XXV.) over the inflamed skin, and is attended by intense irritation. The eruption goes through the same stages as already noted of ordinary herpes, and yellow crusts form. The vesicles attain their full development in 5 or 6 days, and in 8 or 10 days usually the eruption has disappeared. Sometimes successive crops delay the disappearance. Often, especially in the aged, the pain does not cease with the disappearance, but may continue for weeks and months. It does not recur.

Treatment.—No known treatment is of any use to check the disease. It must be allowed to run its course. All that should be done is to diminish the irritation as much as possible by dusting the part with powder, and covering it with cotton-wool, held in position by a bandage, to prevent rubbing with the clothes. Application of the lysol dressing in the manner described for ulcer will be found very soothing. Sometimes the pain is so great that it is necessary to give doses of opium to relieve it and to procure sleep. When the neuralgic pain continues, quinine, iron, and arsenic tonics are valuable. (See PRESCRIPTIONS—TONICS.)

Pemphigus is a disease of the skin attended by the formation of blebs (bullæ). These are like blisters, larger than vesicles, varying in size between a millet-seed and an apple, and are filled with a clear yellowish or muddy fluid. The skin on which they rest is slightly inflamed. They come out in successive crops over various parts of the body, except the head, palms of the hands, and soles of the feet. The fluid of the blebs may be absorbed, and the skin over the collapsed sac becomes dry and separates, or the bleb may burst and leave an exposed surface.

Acute cases of the disease occur rarely in adults, but not unfrequently in children. They run their course in three to six weeks without much constitutional disturbance being produced, unless the blebs are large and in frequent crops, when the itching becomes very severe. Only in ill-nourished children, when the eruption is extensive, need any fear of the result be entertained.

Treatment.—Nourishing and generous diet is of great importance. The principle medicine to give is arsenic, but so much caution is necessary for its administration that it should be left entirely in the hands of a physician. Quinine and iron tonic may be given. The skin is to be frequently bathed, and the lysol solution advised for ulcer used.

Eczema (*Moist Tetter—Running Scab*—see Plate XXIV.) in its beginning consists of an eruption of pimples or vesicles or pustules on inflamed and swollen skin. The vesicles burst, or are torn by scratching, and a red weeping surface is produced. The gummy fluid from the torn surface may dry on the inflamed part and crusts be produced. If the crusts be removed, the dull red surface becomes dry and covered with white scales. Thus the appearances presented by the part affected with eczema may vary with the stage of the affection. There is usually intense itching, and the scratching that is occasioned leads to an extension of the disease. The chronic forms of eczema are the most common, but acute attacks are also frequent. They may last not more than a fortnight, or may return in successive attacks, and finally pass into the chronic type. A sense of chilliness along the back and feverishness usually precede the acute form the skin becomes red and swollen, and within 48 hours the eruption appears, which, in a week or ten days, passes through the various stages described. In chronic cases the place affected has often something to do with the appearances produced. In eczema of the head the oozing fluid from the inflamed surface, mixed with secretion from the glands of the hair, readily forms matted crusts among the hair; and, if the part is not kept clean, the condition may spread till the whole scalp is affected. Moreover, in the offensive mass lice, maggots, &c., breed. This is common among ill-nourished unhealthy children (is termed **scald-head or milk-crust**) and may last for years if not treated. When the scabs are removed, a red thickened surface covered with scales is laid bare. The disease easily extends to the lobes of the ear and into the canal of the ear in the form of red cracked skin, weeping or scaly, or coated with scabs. The nostrils may be affected and their openings plugged with thick scabs, the skin of the lip being red and swollen. Eyelids and eyebrows are often involved in the disease.

Eczema also occurs on the surfaces of joints, particularly the knee-joint, or the surfaces on which the limb moves when bending takes place. Owing to the frequent movement painful cracks are formed, and the skin is red, thickened, and crusted. A similar form occurs on hands and feet. That of the feet is ascribed to the pressure of boots, and is on the back of the foot usually; that of the hands is commonly due to irritating substances among which the person works. Thus **grocer's and baker's itch** are forms of eczema, occurring on the hands and arms, and set up by working among salt, sugar, &c., and by the action of heat and moisture. In eczema of the genitals itching is severe and leads to much scratching and tearing. The surface becomes red and thickened, and the affection may extend downwards along the thigh, upwards towards the abdomen, and back to the anus, where it may lead to the formation of painful itching fissures.

Eczema may be caused by the direct action on the skin of irritating agents, examples of which have already been given. Mere scratching will sometimes be sufficient to produce it, the pressure of clothes, &c. It also results, however, from constitutional conditions.

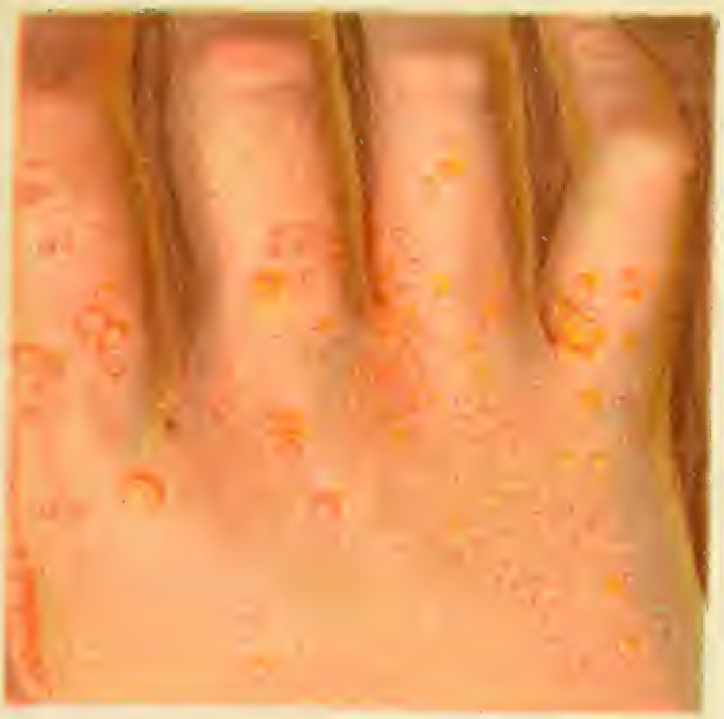
Though eczema is curable, relapses are very common.

Treatment.—Eczema is treated chiefly by applications to the affected part, and not by drugs administered internally. It is a common notion, but quite a mistaken one, that the cure of the disease, so far as it affects the skin, will tend to "drive it inwards" on some more important organ. No such idea ought ever to be permitted to stand in the way of adopting appropriate methods to obtain a cure. A great variety of preparations are adopted, and many cases are very obstinate. It is, therefore, necessary to have the treatment guided by a surgeon. The following simple directions may, however, be found useful. In the stage of swelling and heat, cold-water dressing will afford relief. After the eruption has appeared, dusting with finely-powdered starch, white oxide of zinc powder, or chalk, may be tried. Scabs should be removed after softening with oil, or bread-and-water poultice, or, perhaps best of all, poultices of mashed turnips. These latter are specially valuable in eczema of the scalp. A piece of absorbent wool, soaked in the dilute solution of lysol, and applied as recommended for ulcer, will quickly soften and remove the scabs and crusts. When the scabs have all been removed, simple ointments like vaseline may be applied. A very valuable ointment is made of the yellow oxide of mercury (yellow precipitate) 1 drachm, oil of sweet almonds 1 drachm, lard 6 drachms. This ointment may be applied to the eyes as well as to any other part. For eczema occurring on two surfaces that rub on one another careful bathing and drying, and then the application of vaseline, are sufficient. In particular *all irritating applications are to be avoided.* If the person suffer from depressed health it is advisable to use quinine and iron tonics, and to obtain change of air.

Psoriasis Vulgaris (*Diffuse Dry Tetter*—see Plate XXV.) is a chronic disease of the skin, in which thick layers of shining pearly scales are formed on a reddened and thickened skin. The scales are easily separated by the nails. There is little or no itching, and thus, in one chief point, psoriasis differs from eczema. Large portions of the skin may be affected, or the eruption may occur in little heaps, of the size of pin heads, which gradually enlarge till masses like drops of mortar are produced, and still enlarging may become like coins in size. These patches tend to heal in the centre and spread at the circumference, circles and figures of 8 being produced. As the disease heals, the patches become less raised, the scales being detached, and others not being formed with the same rapidity, and the redness gradually fades till the skin resumes its natural colour. The most common places for psoriasis are the backs of the elbows and the front of the knees. It may also form a ring round the forehead and ears.

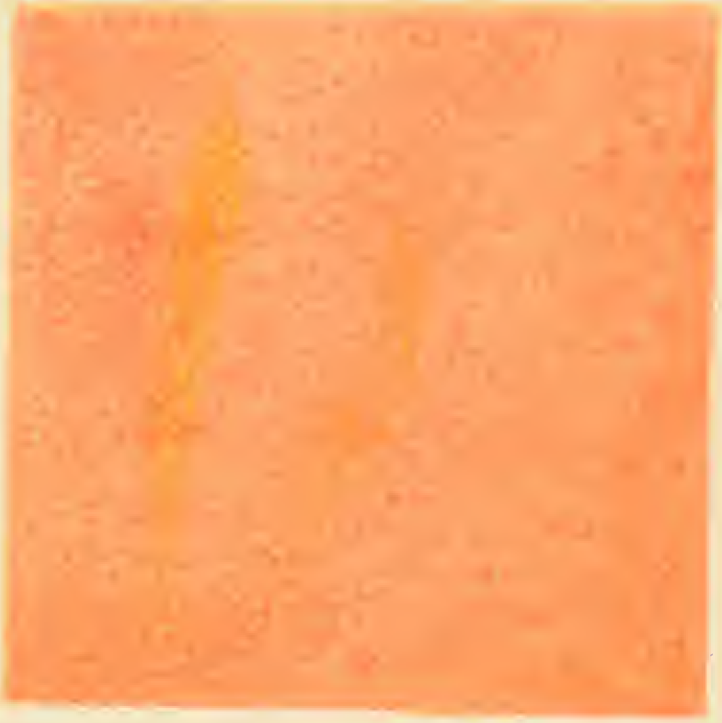
Psoriasis may be cured, but is always liable to return. It is not contagious, but is distinctly transmitted from parents to children.

Treatment.—The most successful application is made of a powder called chrysophanic acid, of which 15 grains are combined with 1 ounce of lard or vaseline. This may be rubbed on the part at once, or after scales have been removed by the use of soft soap. If it irritates too much the ointment may be weakened or discontinued for a time. It stains clothing a deep colour not removed by ordinary washing. Benzole, however, or a weak solution of potash or chlorinated lime will remove the stains. Of more recent remedies, pyrogallic acid ointment (60 grains to 1 ounce of lard) is also useful. It is commonly necessary to combine with the ointment the internal administration of arsenic. A good way of avoiding a mistake with the dose is to have the drug put up in pill, each



Scabies or Itch

p 427



Red Gum Rash. Simple Lichen, or Spotted Heat

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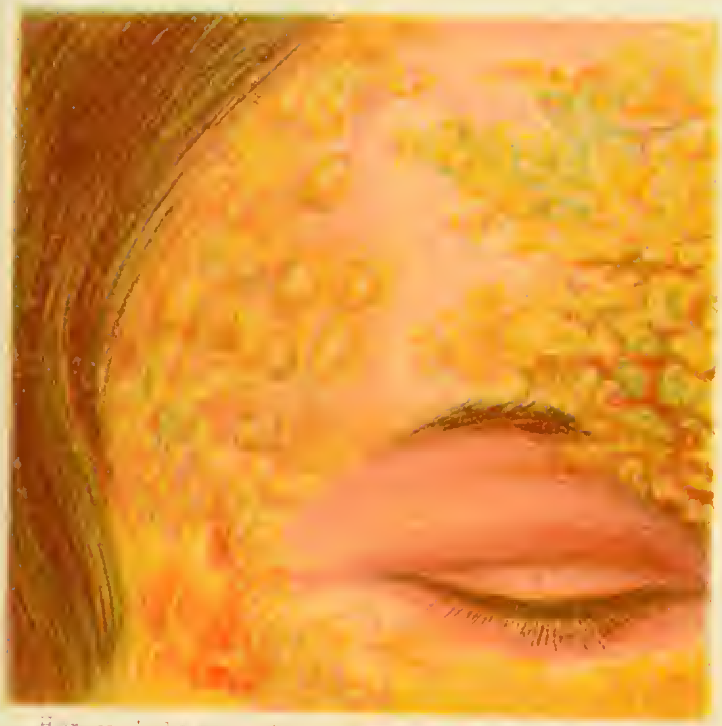
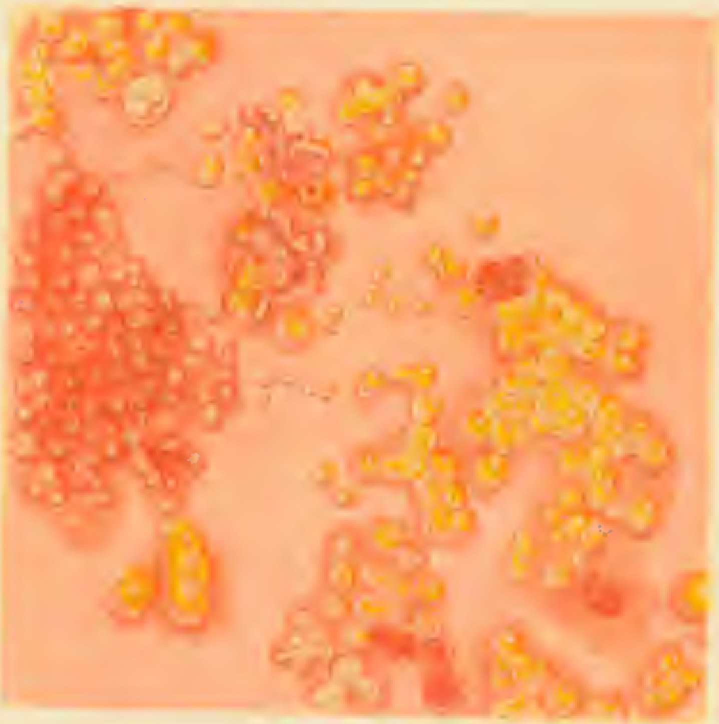


Honey Sukker, Honey Scab, or Pustular Tetter. Impetigo

p 4[illegible]



Shingles. Herpes Zoster

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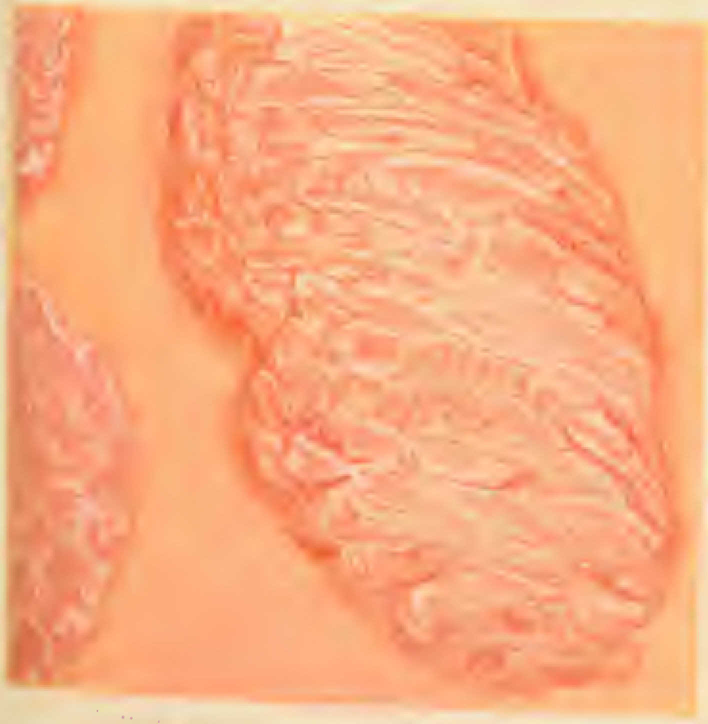

Scaly Dry Tetter. Psoriasis vulgaris

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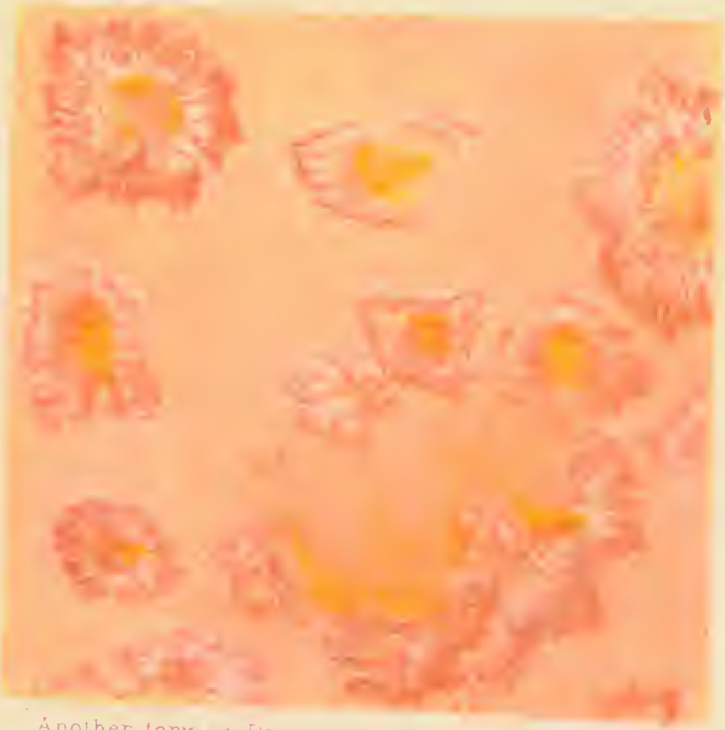

Another form of Psoriasis. Circular Dry Tetter

p 4[illegible]

pill containing 2 grains dried sulphate of iron, $\frac{1}{20}$th of a grain arseniate of soda, and 1 grain extract of gentian. One pill should be taken thrice daily *after meals.* The pills should be continued for a long period, *should never be stopped abruptly,* but, when it is desired to cease taking them, the dose should be gradually diminished—2½ pills daily, then after some days 2 pills daily, and so on, till, after the lapse of a fortnight or so, the dose has been gradually reduced to nothing. *On the whole, however, such drugs should not be taken without the direction and guidance of a physician; and no one, of course, would give such a medicine to children unless the correct dose were regulated by a medical man.*

The internal administration of thyroid extract in extensive cases of the disease produces sometimes remarkable results; the affected skin being shed in sheets, leaving healthy skin in its place.

Dandruff (*Brawny Tetter—Pityriasis*) is a chronic disease of the skin in which a quantity of fine scales is continually being produced and shed. The skin is sometimes slightly red, and there is some amount of itching present. Any part of the skin may be affected, but the scalp is specially apt to be the seat of the disease, chiefly in children and old persons. It is a very chronic affection. The distinguished German authority on skin disease—Hebra—has shown it to be really due to excessive secretion of the glands connected with the hair follicles—the sebaceous glands (p. 414).

Treatment.—A free use of soap is advised, or the use of an alkaline solution, such as the carbonate of potash (salt of tartar), of the strength of 60 grains to the half-pint of water. An ointment consisting of one part of red precipitate ointment and three of lard is useful for the scalp.

Impetigo, Plate XXV. (*Pustular Tetter—Honey Sickness—Honey Scab*).—This is an inflammation of the skin in which a flattened eruption containing matter is formed. The matter soon dries up and leaves yellow crusts or scabs. When the scabs are removed a raw surface is left. Heat and itching are severe. It occurs on the face and head and sometimes on the hands. It is accompanied by feverishness and sensations of chilliness. The disease runs its course in about a fortnight, but may be prolonged by successive crops. The matter of the pustules is capable of producing pustules on healthy parts by being inoculated.

Treatment.—Remove the scabs by the use of the lysol application (p. 423). Thereafter the ointment recommended in the immediately preceding article, with the addition of 20 drops of carbolic acid, well mixed, is to be applied to the affected parts.

Lichen Simplex, Plate XXV. (*Strophulus—Red-gum Rash*).—Lichen is characterized by an eruption of minute red pimples, which last about five or six days, are accompanied by much local irritation, itching, and tingling, and sometimes constitutional disturbance such as headache and feverishness, and whose disappearance is followed by slight shedding of scales of the skin. The pimples are solid, that is contain no fluid, and make the skin feel very rough. The face or arms are usually affected, but other parts also. The tops of the pimples may be torn off by scratching, and a minute crust of blood may cover them, altering the appearance of the eruption. The eruption may be mistaken for measles.

Strophulus, Red Gum, or **Tooth Rash,** appearing in infants, is similar to the eruption of lichen, and has been classed with it.

Treatment.—Mild opening medicine should be given, to children fluid magnesia. Tepid baths are of great use in allaying irritation, and should be frequently employed, specially the lysol bath, for a child a table-spoonful of lysol thoroughly stirred into the ordinary child's bath. All irritating agents should be removed from contact with the skin. Thus flannel should not be worn next the skin. Plain diet, milk, &c., is the most suitable. Internal remedies are sometimes necessary, but these should be prescribed by a physician.

OVERGROWTHS, NEW GROWTHS, AND HÆMORRHAGES.

Barbados Leg (*Elephantiasis Arabum*) is so named from its frequent occurrence in Barbados. It is common in hot climates — the West Indies, India, Arabia, Egypt, China, and the west coast of Africa.

It consists of an overgrowth of the skin and connective tissue, attended by inflammation, and involving blood-vessels and lymphatics. The parts usually affected are the legs or the genital organs. The skin is so greatly thickened and thrown into folds, and the feet and toes are so masked, when the leg is affected, by the enormous overgrowths, that the appearance of an elephant's leg is produced, hence the term elephantiasis. When the genital organs are affected, tumours of great size may be formed, reaching down towards the knee or beyond it. Tumours of this kind weighing 100 pounds have been removed by operation.

Symptoms.—The disease begins by attacks of fever occurring at intervals, like attacks of intermittent fever, and accompanied by inflammation and swelling of the affected part. When it occurs in the genital organs these parts are swollen, the pain is often intense, passing up the groin, and accompanied by vomiting and other signs of constitutional disturbance. The lymphatics may become dilated, forming blebs from which lymph may escape. With the recurring attacks the overgrowth of the skin gradually occurs, until the great size and remarkable appearances already noted are produced. Large ulcers are sometimes formed in the skin, from which a foul discharge escapes.

The **cause** of the disease is not understood. Some are disposed to regard it as hereditary, while others are disposed to regard it as an affection of lymphatic vessels. Large numbers of a parasite (the *Filaria sanguinis hominis*—see p. 317) have been found in the blood of those suffering from it. Climate, there is no doubt, has much to do with it—many believing it to be due to malaria—and the removal of the person from the place where the disease prevails, if accomplished in the earliest stages, is one of the best means of treatment. Men are equally liable to it as women, but it rarely attacks before puberty.

Persons may suffer from elephantiasis for years without the general health suffering, the increased growth being arrested, or slow overgrowth going on without recurrence of fever. The progress of the disease may thus be slow.

Treatment.—It is sufficient to state here that the best thing is to remove the patient from the district to some place where the disease does not occur. Europeans who contracted the disease in India have recovered on returning to Europe. Removal must, however, be very early. The tumour may be removed by surgical operation, and this should always be done where it occurs on the genitals.

Fish-skin Disease (*Ichthyosis*) is an affection in which there is an enormous overgrowth of the scarf-skin. The true skin is also thickened. Furrows are deepened, and thus the skin is mapped out into irregular areas, and the appearance of crocodile's hide produced. Masses of the overgrown cells may vary in colour, being of a pearly colour, or varying to brown and black. The disease is usually most marked over elbows and knees. Sometimes the only inconvenience produced by it is slight itching. The disease may be transmitted from parent to child, and commonly becomes apparent in the child at about two years of age. It is not fatal, but does not easily yield to treatment, though it may be improved for a time.

Treatment consists in frequent warm baths, and rubbing the skin with oil, soft soap, &c., to soften and remove the scaly masses.

Leprosy (*Leprosy of the Jews, Lepra, Elephantiasis Græcorum*).—This is the leprosy spoken of in the Bible, and is to be distinguished from Elephantiasis Arabum—Barbados Leg. It was at one time prevalent in England and Scotland, but is now extinct. It flourishes in Norway and Iceland, the coasts of the Black Sea and Mediterranean, in Madagascar, Mauritius, Madeira, the Greek Archipelago, East and West Indies, Palestine, &c.

It is probably contagious, though that is not certain. At any rate, it is transmitted from parents to children, more frequently by the mother than the father. It usually commences in early adult life. It seems to have arisen in marshy districts on the banks of the Nile; and it was at its worst during the Crusades of the eleventh and twelfth centuries.

Three varieties of leprosy are described. One form is spotted leprosy, in which reddish coppery spots appear on the skin, and are met with on the mucous membrane of the mouth, throat, nostrils, and eyes. They spread at the margins, and after a time become paler at the centre, smooth, and shining. The redness may disappear and leave a bronzed stain or an unnatural whiteness. This form may exist for a long time, appearing and disappearing. The reappearance is frequently preceded and accompanied by fever, a feeling of languor, dulness of spirits, chilliness, and a general feeling of illness. The second form is a more advanced stage. The patches are no longer discolorations of the skin, but are raised, and form tubercles, thickenings in the skin, varying in size from a small shot to a nut. They appear specially on the hands, arms, and feet, and on the face. A remarkable alteration is produced in the appearance by them. Along the eyebrows the tubercles produce a frowning look. The hair of the eyebrows falls out, a thickened nodulated appearance of the whole face results from tubercles over nose, cheeks, chin, and lips, so that a lion-like ruggedness is imparted to the face. Hands and feet become deformed; abscesses and ulcers form; fingers and toes may be lost by death of the parts. Hair disappears from the affected patches, and nails become cracked and distorted. In the third variety patches of skin become insensible, but surrounded by over-sensitive regions of skin. Wasting of the skin sets in, and wasting of muscles and bones. The fingers are remarkable for thinness. As a result of wasting, deformity and mutilation are produced. The early stage of this variety is characterized by the formation of blebs on the skin, which burst and leave behind inflamed and ulcerated surfaces. When the ulcers heal, white, smooth, depressed scars, without hair and deprived of sensitiveness, remain. The various kinds of the disease may be seen on one individual.

Leprosy is a fatal disease, though it may be slow. Death may arise from exhaustion or affections of lungs or bowels. The tubercular form lasts on an average eight or ten years, and the form attended by loss of sensation (the anæsthetic form) may last for twenty years.

Treatment consists in removing the person from the district where the disease prevails, in strict cleanliness, in attention to diet, &c. The general health is to be maintained by nourishing food, tonics, exercise, fresh air, &c. Cod-liver oil, and various other kinds of oil, have been used, and may be used, but are of little value, except as they help the general strength.

Lupus (*Noli me tangere*).—The term *lupus* means a wolf, and has been applied to this disease because of its destructive tendency.

It consists in the formation of little groups of cells in the substance of the skin. The nodules thus produced may soften and break down, so that ulceration is produced; or the new growth may, after a time, disappear; but absorption of the tissue around occurs, and, owing to the loss of substance, depressed white scars occur. In the common form (**lupus vulgaris**) dull red nodules, resembling reddish transparent jelly, and of the size of a pin's head or a small shot, occur in groups or scattered in the skin. They slowly increase in size and number, sometimes forming tubercles by joining. They may remain without change for a long time, and then slowly disappear, leaving a white scar lower than the level of the rest of the skin. As the nodules disappear at one part, they appear beyond, and so a considerable extent of skin may be destroyed. They occur most frequently on the face and nose.

The nodules may ulcerate, and lead in this way to great loss of the skin and structures beneath it. As the ulcer slowly heals in the centre it spreads round the margin by formation of new nodules, which in turn break down. The nose is often destroyed in this way.

Another form—inflammatory (*lupus erythematosus*)—occurs upon the face and head, appearing as a red patch on the nose, and later as red patches on each cheek. Spreading gradually at the margin, the patches unite and produce a "butterfly" appearance, their centres becoming whitish, shrunken, and flat. It has for some time been believed to be a variety of tubercular disease, the bacillus being found in the diseased skin.

The disease attacks the wrists and trunk as well as the face, is most common between the ages of two and eighteen, tends to disappear with age, and is more common in women than men. It is not contagious. It is very tedious and very difficult of treatment.

Treatment consists in the administration of nourishing food, tonics, cod-liver oil, and in the use of caustics and other means for destroying the growth. One of the most easily applied of these is salicylic acid dissolved in collodion to the extent of 25 or 30 per cent, with the addition of 10 or 15 per cent of creasote. This, painted on, rapidly dries. It destroys the diseased skin, affecting the healthy skin but little. Treatment by Roentgen rays, or by means of special apparatus—the Finsen lamp—by light, is very satisfactory in many cases.

Freckles are brown spots of various degrees of darkness, which occur on the skin of fair people, particularly on the exposed parts, such as face, neck, wrists, and hands. The action of light brings them out, and in summer they are specially dark.

Treatment.—The best application is a lotion of bitter almonds, made by pounding up twenty bitter almonds into a paste with water, adding water to 5 ounces, and dissolving in it 2 grains of bichloride of mercury. This is very poisonous, and ought so to be labelled. The lotion is applied with a soft sponge and allowed to dry on.

Sunburn (*Tan*) consists of irregular patches of discoloration produced by the action of the sun's rays. The lotion advised for freckles is good for it.

Cloasma, often called *liver spots,* formed of patches of a pale or brown-yellow, occurs specially on the face, neck, and trunk. It is common in pregnant women. The lotion of bitter almonds may be used for this as for freckles.

Moles (*Mother's Marks, Nævi*) are spots or patches which, in some cases, consist simply of skin with excessive deposition of colouring matter, and in others of masses of dilated fine blood-vessels. For the latter see p. 327. The former kind is sometimes covered with long hairs. If it is not situated on an exposed part, the mole should be left alone. If it disfigures, it may be touched from time to time by glacial acetic acid, applied by a fine brush, care being taken that no acid comes in contact with sound skin. Even should this destroy the mole, a scar will always remain. A surgeon might be able to cut it out so as to leave less of a mark.

Warts are small outgrowths of skin with its covering of epidermis. They are hard when over ordinary skin, soft when on mucous membranes, such as that of the lips and private parts, or on skin kept moist. The salicylic acid in collodion, advised for lupus, is the best application. Sometimes they come out rapidly in crops, and sometimes suddenly begin to disappear.

Corns are formed by excessive growth of the cells of the epidermal layer of the skin, excited by overpressure on the part—the pressure of a tight boot, for example. The pressure of the accumulated mass of cells causes wasting of the skin beneath it, and thus the corn comes to lie in a sort of pit.

Treatment.—The feet should be frequently bathed in warm water to soften the corns, which are then rubbed down with a file or pumice stone. To protect the part from undue pressure a corn plaster is put on. It consists of a soft circular or oval pad of cotton fixed to adhesive plaster on one surface, and with a hole in the centre. The plaster is placed so that the hole is directly over the corn, and so protects it. But prevention is better than cure, and if boots of a proper size, and well fitting, are always worn, corns will not readily form. Soft corns, which occur between the toes, are easily destroyed by the application of glacial acetic acid.

Horns, consisting of curved brownish masses of epidermis, sometimes occur on the head. They should be cut out.

Purpura Hæmorrhagica, in which deep red spots of various sizes appear on the skin, usually of the legs, is rather a constitutional than a skin disease, and is described on p. 317.

Cancer is common in the skin and mucous membranes, in the form of **epithelioma** or **skin-cancer.** This is formed of an enormous increase of epithelial cells similar to those of the epidermis, which exist as hard nodules in the skin, slightly raised above the surface. In time an ulcer is formed, with prominent, irregular, and hard edges, with an irregular warty floor, and discharging thin unhealthy matter. Its commonest place is on the lip, and it rarely occurs under forty years of age. It is also met with on the face and on the external genital organs. If not removed early, the disease spreads to lymphatic vessels and glands. Moreover, the disease spreads in all directions in the immediate neighbourhood by multiplication of the cells, and the ulcer spreads by breaking down of the new growth.

In women cancer involving the skin of the breast is common, and is considered in Section XXV., p. 558. **Chimney-sweeper's cancer** is the epithelial form occurring in the external genital organs.

The proper **treatment** is removal by the knife; and if this is done early and thoroughly there is good hope of the disease not returning.

ITCHING DISEASES AND DISEASES DUE TO PARASITES.

Itching (*Pruritus*) is a condition of perverted sensibility of the skin. It is not to be regarded as a disease in itself, but merely as a symptom of a disease, and it may accompany various disorders. Itching may be present in a very annoying degree without any eruption of the skin at all. But if it is severe, and lasts for any time, the mere mechanical injury inflicted by the nails of the person is likely to produce considerable changes in the appearance of the skin, in the shape of scratches, tender and bleeding spots or patches, from which the protective scarf-skin has been removed, and inflammation and thickening of the affected parts. If the itching attends an eruption the characters of the eruption are considerably altered by the tearing, the tops being scratched off pimples, which are thus made to bleed, and then the blood dries and forms a red crust or cap to the pimple, &c. The itching may be confined to parts of the body or may be spread more or less over the whole body.

1. Itching is very often due to the presence of the itch insect (see The Itch), or the louse (see Lousiness, p. 432), or to the parasite of ringworm (see Ringworm, p. 434).

2. It may be caused by the irritation of rough clothing.

3. It may arise because of inflammation of the skin. Thus eczema (p. 425), lichen (p. 427), and sometimes psoriasis (p. 426) and pemphigus (p. 425), are accompanied by itching.

4. It may be due to constitutional and various other diseases. Thus an intense itching about the private parts is often caused by diabetes (p. 407), even in cases where no other symptoms lead to the suspicion of that disease. Itching about the anus is frequently the result of piles. In jaundice the retention of certain biliary constituents in the blood produces itching of the skin. Irritations of the intestinal canal, caused, for example, by worms, irritative affections of the womb, and affections of the kidney and bladder, may lead to it. In old people changes in the skin, resulting from old age, may cause it.

5. Certain drugs, such as opium and copaiba, after being taken inwardly, tend to produce a general itchiness of the skin.

Treatment.—As soon as the cause has been found the remedy may be easy. Insects should be destroyed, disease of kidney, womb, &c., should be treated, irritation removed if possible, and so probably the itching will disappear. Where no cause can be discovered, tonics (iron and quinine) should be given; the person should not wear flannel next his skin, and frequent bathing with water in which ordinary soda is dissolved should be resorted to. A lotion is also recommended consisting of Wright's liquor carbonis detergens, ½ ounce in 8 ounces of water, and 1 ounce of glycerine. With this the parts should be sponged. Soda baths, lysol baths, starch baths, are all useful. After drying, the body should be lightly smeared with menthol oil (30 grains menthol in 6 ozs. olive-oil).

The Itch (*Scabies*).—This is an itching disease due to the irritation of the itch insect (**Acarus scabiei**), in which the skin is inflamed (Plate XXV.).

The male itch insect is represented in Fig. 167. It is just large enough to be seen with the naked eye, has eight legs, and a number of projecting spines from its under surface. The female is slightly larger than the male, being about $\frac{1}{80}$th to $\frac{1}{60}$th of an inch long, and on the ends of the four front legs it has suckers, while the hind-legs end in long hairs. In the male two of the hind-legs have suckers. When the female is placed on the skin it bores its way into the epidermis, and, after lying embedded for a little, lays an egg. To make room it bores a little farther along, then lays another egg. Daily a fresh egg is laid, the insect meanwhile advancing and penetrating into the skin till it has bored a tunnel which passes more deeply into the skin the farther it is carried. With the growth of the skin, and the shedding of the cast-off cells of the epidermis, the tunnel is brought nearer to the surface, till the first egg is exposed, about the time it is hatched. Fourteen days usually elapse between the laying and hatching of an egg. In one tunnel there are about fifteen eggs. The young insect has at first only six legs, two of the hind-legs being wanting till after it has shed its first skin. The young insects escape from the burrow to the surface of the skin. The females meet males, become impregnated, and proceed themselves to burrow. The adult female insect dies at the end of her tunnel. The male insects run about on the surface. Fig. 168 represents a female acarus at the end of its burrow and a series of eggs behind it.

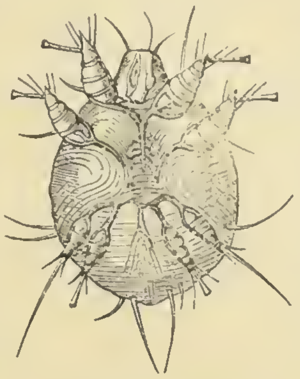
Fig. 167.—The Male Itch Insect (magnified).

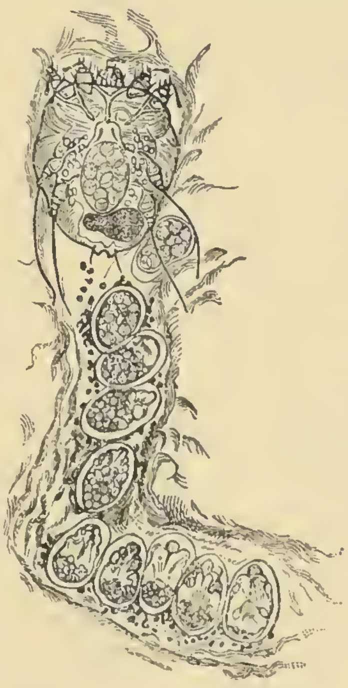
Fig. 168.—Itch burrow with female Itch Insect at one end and the eggs behind (magnified).

Symptoms. — The disease usually attacks the webs between the fingers, the front of the wrists and elbows, and the lower part of the belly, the nipple in the female, the buttocks, and the genitals. The feet and legs are attacked in children. There is intense itching, worse at night, or whenever the person becomes warm. The scratching induced, as well as the irritation excited by the burrowing of the parasites, leads to a scattered inflammation of the skin; swollen lines, pimples capped with crusts of dried blood, blisters and pustules are formed. The chief thing to be looked for is the burrow, which is like an old pin-scratch. It is irregular in shape, from half a line to 3 inches long, with a whitish dotted appearance, the dots being the eggs, and a little mound at the deep end, where the adult acarus lies. If all the canal has been opened up it may simply appear as a dirty ragged line.

Treatment is simple and effective. The affected person should take a hot bath, and should thoroughly scrub the whole body, except the head, with soap and water. Persons with thick and not very sensitive skin may use soft soap. After the bath the whole body, and especially the parts where the eruption is, must be well anointed with sulphur ointment, either the simple or compound sulphur ointment of druggists. The ointment should be well rubbed in. If it is properly done, one application is sufficient. An ointment may be made of subcarbonate of potash (1 drachm), sulphur (2 drachms), and lard (12 drachms). In the morning after the use of the ointment a warm bath should be taken. To destroy insects on the person's clothes they should be steeped in boiling water, or exposed for some time to air at a temperature of 150° Fahrenheit, or ironed thoroughly all over with hot irons.

Lousiness (*Phthiriasis*).—Three kinds of lice may be harboured on the human body—the head-louse (*Pediculus capitis*), the body louse (*Pediculus corporis*), and the louse found on hairy parts except the head, and specially on the pubis—the crab-louse (*Pediculus pubis*), each kind limiting itself to its special region of the body. The **head-louse** is shown in Fig. 169. It has a body of seven segments, an oval head, provided with feelers (antennæ), and six legs, three on each side, which are hairy, and terminate in claws. The head has two simple eyes and is provided with biting and sucking apparatus. The animal is able to bite into the skin and then to insert its proboscis into the wound in order to suck blood. The head-louse confines itself to the scalp, running about amongst the hairs, where it is capable of multiplying with great rapidity by means of eggs. The eggs (nits) are firmly attached to the hairs by means of sheaths, and from them the young escape at the end of nine days, and are fully developed at the end of eighteen. The lice are found in greatest abundance in the back and side portions of the head. "A single louse may lay fifty eggs within six days, which may be hatched in from three to eight days. The 'young ones' are capable of laying eggs themselves in another eighteen days or three weeks. A pregnant louse, therefore, may be the means of bringing forth some 5000 young ones in the course of eight weeks" (Professor Hebra). In women and children, because of their long hair, lice are more common than in men.

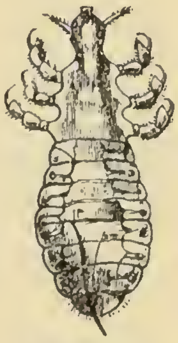
Fig. 169.—The Head-louse.

Very severe **symptoms** may be produced by the insects. Their biting irritates and wounds the skin. It also renders the skin itchy, and the person scratches. Between the two an inflammation of the skin is produced, an eczema (p. 425). The skin is torn with scratching, and blood escapes, which dries into crusts. An eruption of blisters of the size of a pin's head or a pea appears. These are torn and weeping, and the fluid dries up also into crusts. Beneath the crusts matter forms, and the hair becomes matted together and covered with nits. This condition of things, if not promptly attended to, spreads, and a foul, matted mass of scab and entangled hair is produced, among which the lice continue to breed. On the neck, but lessening from above downwards, scratches, pustules, &c., also are present, and the ears may be affected. The glands of the neck readily become swollen, and often in children swollen and running glands in the neck are due entirely to the irritation of such a condition of affairs in the head (see p. 284).

Treatment.—Hebra advises the following treatment. A mixture of 3 ounces common petroleum, 1½ ounce olive-oil, and 2½ drachms balsam of Peru is made, and the hair treated with it down to the very roots every hour for a considerable number of hours. The head is covered with a flannel cap. After 24 or 48 hours, when the lice and their eggs will all be destroyed by the petroleum, the head is to be thoroughly washed with soap and water. The oil not only kills the animals, but also loosens the scabs, and the washing should remove them all. Matted hair is to be combed out by careful and patient combing, beginning at the ends of the hair. If an inflamed condition of head remains it should be treated as directed for eczema. The nits, though killed, are not removed by this method To remove them, bathe the hair with vinegar and water. This softens their sheaths. Afterwards they are removed by fine-toothed combs.

In milder cases, where no scabs have been formed, and where all that is desired is the destruction of the lice, which are easily got at, it is sufficient to rub well into the hair some ointment of mercury, such as the blue ointment, or the red precipitate ointment.

The **body-louse** or clothes' louse resembles the head-louse, but is larger and more active. It is never met with on the head or hairy parts. It lives not on the skin, but in the folds of the clothing, whence it only sallies out to seek nourishment, obtained by piercing the surface layers of the skin and sucking.

Symptoms.—The irritation of the insect's bite produces a red spot, in the centre of which is a minute purplish speck, due to escape of blood. Severe itching is occasioned, and as the spot is slightly raised above the surface it is torn by the nails and bleeds. Scratches covered with blood-crusts are thus produced. Various other kinds of eruptions may be caused, blisters, pustules, scabs, &c. Where the itching and scratching have gone on for a long time, the constant redness of the skin excited thereby leads to a darkening of the colour, most pronounced on the neck, wrist, and buttocks. In extreme cases boils and ulcers are produced. In spite of such signs, supplying unmistakable evidence of the presence of lice, if the person be stripped not a single animal may be found on his body, because they hide themselves in the folds of the clothing.

The **treatment** for body-louse consists in removing the garments in which the parasites lie hid. To kill them and their eggs they should be ironed with very hot irons, the folds and creases of the clothing being ironed over specially time after time. The sores on the body should be treated by simple dressings.

The **crab-louse** (Fig. 170) or pubic louse is flatter, broader, and shorter than the other forms. It lives chiefly in the hairy parts at the lower part of the abdomen—the pubic region,—but may be found on the armpits, among the hairs of the breast, &c., but never on the head. It grasps the hairs firmly with its front feet, making its removal difficult. The nits are fixed on the hair quite close to the skin.

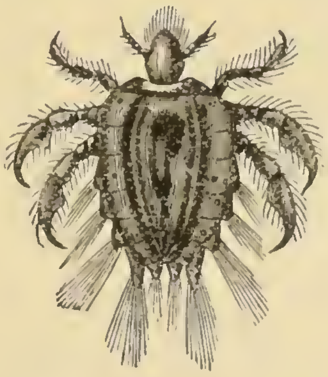
Fig. 170.—The Crab-louse, more highly magnified than Fig. 169.

Symptoms.—Itching is less severe than in the case of the head or body louse, but a pimply eruption may be induced.

Treatment is commonly by blue ointment of mercury. It is, however, apt to excite inflammation of the skin, and must, therefore, be cautiously used.

ERUPTIONS PRODUCED BY FLEAS, BUGS, &c.

The common flea (*Pulex irritans*) produces rose spots with a purplish point in the centre. When the surrounding redness fades the central spot remains still dark, and cannot be made to disappear even momentarily by pressure of the finger. Within two or three days it passes through the changes of colour common to any bruise and then disappears. In sensitive skins a kind of nettle-rash may be produced.

Bugs (*Cimex lectularis*) hide in cracks of wood-work, bed-furniture, &c. They are much larger than fleas or lice, and are of a rusty brown colour.

They cause intense itching and large wheals by their bites, and an eruption like nettle-rash may be brought out, which is well-marked in the morning, and fades in the course of the day, to be again well-marked next morning.

The harvest-bug (*Leptus autumnalis*) embeds itself in the skin, and produces a pimply eruption, accompanied by itching, which increases whenever the body grows warm, as after being in bed for some time at night.

Treatment.—The itching in any of these cases may be allayed by a lotion of percloride of mercury, 2 grains to the ounce of water. A stronger lotion of the same sort may be used to wash over cracks of wooden beds, &c., for the destruction of the insects. Great care must be exercised in its use, for it is very poisonous. The same end may be served by using a mixture of 3 parts unpurified petroleum to 100 parts of water. Fumigating a house with sulphur also destroys bugs.

The harvest bug is a great pest in some country districts and in gardens, where many people dare not enjoy the luxury of gooseberry eating from the bushes, lest they be attacked by the insect. Rubbing the skin of the legs lightly with cedar-wood oil is an absolute preventive in such cases.

Ringworm (*Tinea*) occurs in three varieties, according as it attacks the scalp, the beard, or some other part of the body. In all cases it is due to the same cause, the presence of a vegetable parasite, consisting of minute round bodies, and of thread-like structures formed of rows of rod-shaped bodies of a beaded appearance. This is the growing fungus and its spores. To it the name **trichophyton** has been applied. Wherever ringworm occurs this is present between the layers of cells of the scarf-skin, in hairs and hair sheaths.

Ringworm of the body (*Tinea circinata*) is the name given to the disease when it occurs on the non-hairy parts of the body. It is most common on the face, neck, and trunk, and is found also on hands, arms, and wrists. It consists of small circular patches slightly raised and of a rose colour, and covered with small branny scales. Usually round the margin is a ring of very small blisters. The spot is the seat of a tingling and itching sensation. It spreads round the margins, and as it spreads heals in the centre, so that a large red ring with a pale centre is formed. When a large ring has been formed it often becomes irregular. The disease may end of itself. On the other hand, it may spread and other rings may form on other parts because of the person scratching the diseased part, and carrying some of the fungus under finger-nails to some sound parts.

Ringworm of the scalp (*Tinea tonsurans*) begins by small red patches like the ringworm of the body and spreads at the margins (Plate XXIV.). It involves the hairs, which become penetrated by the fungus, and are dull, dry, and twisted. They are easily pulled out, and become very brittle, themselves breaking off near the skin and leaving projecting discoloured stumps. The affected patch becomes covered with a grayish-white powder. Inflammation may be produced and crusts formed. The hairs, if pulled out and examined, are easily seen to be very much thickened. In advanced cases of the disease the hair follicles may be destroyed and a bald patch be left when the disease has disappeared. Several patches of the disease may exist, and by spreading unite, forming one large irregular patch.

The disease of the scalp is commonest in children.

Ringworm of the beard (*Tinea sycosis*) has similar appearances—patches, red and circular, covered with fine scales, with stubbly, dirty-looking brittle hairs. The hair follicles become swollen and tender, and matter forms round them, becoming crusted. It may persist for months or years.

Treatment.—For ringworm of the body a lotion of bichloride of mercury (2 grains to the ounce of water) is often sufficient to kill the fungus. It can be frequently applied. If this is insufficient, tincture of iodine painted all round the spreading margins of the ring will usually succeed. It may be repeated if necessary. In ringworm of the head and beard the hair of the diseased patches, and for a little distance beyond, should be cut short; crusts should be removed by the application of poultices, by the use of plenty of oil, and by frequent washing with water and soft soap. The lotion of bichloride of mercury should then be applied. This treatment is much more certain of success if all diseased hairs are removed. This is done by catching them one after another by pincers and pulling them out, not one being left behind. If the patches are large, small bits may be cleared of hair at a time until, after several times, the whole patch has been cleared. The lotion should be well applied several times after all sign of the continued advance of the disease has disappeared. It may take months before the disease is finally got rid of. Meanwhile, if the person is not in vigorous health, cod-liver oil, tonics, and good food should be administered, and strict cleanliness practised.

Honey-comb or **Crusted Ringworm** (*Tinea Favosa—Favus*) is figured in Plate XXIV. It is caused by a fungus resembling that of ordinary ringworm. To it the name **achorion Schönleinii** has been given. It attacks the scalp. Small itchy red patches appear first, then minute yellow specks, which gradually become larger till they attain some considerable size—some may even become as large as ½ inch in diameter. They form yellow crusts, depressed in the centre so as to be cup-shaped, through which a hair passes. There is itching of the parts; the hairs become dull, dry, and ash-gray, and they are brittle. In the end they may be destroyed and fall out. When the crusts are removed pits are left in the skin, which, however, soon fill up. The crusts have a disagreeable mousy odour. The disease may last for years. It is contagious, and has been known to be transmitted from mice affected by it to the cat which caught them, and from the cat to children, whose pet it was.

Treatment.—It is necessary that the diseased hairs should be pulled out from the root. Forceps are required, and the difficulty in removing the hairs is due to their brittleness and tendency to break off short. It may take many weeks before the removal of hairs in this way can be stopped without risk of the disease recurring. During the removal of the hairs the perchloride of mercury lotion (2 grains to the ounce of water) should be rubbed into the part to destroy the fungus. Nourishing food and tonics should be given.

Pityriasis versicolor is a disease of the skin, occurring in patches of a peculiar brownish colour, and due to a vegetable parasite called the **Microsporon furfur.** It begins in small spots about the size of a pin's head. They extend and unite, large irregular patches of the discoloration being produced. Itching is not great, and, on scratching, yellowish scales come from the patch. Children are seldom attacked. Persons who perspire freely and are not sufficiently cleanly, who do not use frequent bathing, may have it for years. It occurs chiefly on the chest and abdomen.

Treatment.—The affected parts should be washed with soft soap and water to remove greasiness, and then dried. The skin is then damped all over with vinegar, and while still wet with it, is sponged with a lotion of—

Hyposulphite of soda,............	6 drachms.
Glycerine,...........................	1½ ,,
Water,................................	6 ounces.

This is daily repeated for a week. Thereafter the skin should be inspected every few days for a time to see that no patch has escaped.

AFFECTIONS OF THE GLANDS OF THE SKIN.

Excessive Secretion of the Sebaceous Glands (*Seborrhœa*).—The sebaceous glands separate an oily fluid which keeps the skin moist and soft. This is produced in excessive quantity in the disease named. It occurs specially in young people between fifteen and twenty-five, on the cheeks, nose, and forehead. The skin has a greasy appearance, and minute drops of oil may be seen standing upon it. The face of a person affected seldom appears clean, because dust, &c., so readily adheres to the greasy surface. In old-standing cases the sebum forms flakes or crusts upon the skin of a pale-yellow, brown, or grayish colour. When this occurs on the head the hair becomes matted together. This may be seen in children. The affection occurs also on the genital organs of both sexes.

In another form scales of dry secretion of a dirty-white or pale-yellow colour adhere to the surface of the skin, or the sebum assumes the appearance of branny scales, forming a fine mealy powder. This often forms on the scalp, and if allowed to accumulate forms scurf. In the disease the hair is affected and readily falls off, so that scurf and hair are continually falling from the head.

Treatment.—Thorough cleanliness is necessary. In the oily form on the face frequent washing with soap and water, and rubbing with towels, is the best treatment. Before the soap and water, oil may be rubbed over the parts to soften and bring away plugs of sebum in the mouths of the glands. If crusts have formed they should be softened and removed by rubbing with oil, and then soap and water. An ointment of oxide of zinc may then be applied, or the lotion of almond emulsion with 1 grain perchloride of mercury to the 10 ounces. This is, it must be noted, poisonous. Tonic treatment may also be needed.

Comedones (*Grub*, *Shilfcorn*) is the term applied to plugs of sebum that block the mouths of the hair follicles and glands. They appear as small dark points, and when pressure is applied by the finger-nails a little worm-like body with a black head is squeezed out. This is simply accumulated secretion, the exposed end being blackened by dirt. A parasite has also been found among the secretion—the **Acarus folliculorum,**—which, however, does not seem to give rise to any symptoms

Comedones vary in size, and, if numerous, their black points are very unsightly. They are found most commonly on the face, back, and chest.

Treatment. — The accumulated material should be squeezed out by the finger-nails. Frequent washing with soap and water, followed by brisk rubbing, should be adopted to prevent their recurrence. Previous anointing with oil is an aid to the removal of the retained material.

Milia are small, white, round bodies lying beneath the scarf-skin, most commonly on the eyelids and cheeks. They are formed of sebaceous glands which have become filled with their secretion and unable to expel it.

Treatment.—A sharp needle readily slits up the cuticle covering the little body, which slight pressure then turns out.

Wens are tumours formed like milia, but much larger in size. They may attain the size of a nut or orange, and are common on the head and face. They are enormously distended sacs of the hair and hair-gland, containing accumulated sebum which may have undergone alteration.

The treatment is usually to dissect them out entire, or to open them out and clear out the contents. The operation, if the wen be on the scalp, is not unattended with risk. Erysipelas may arise; and great care is exercised by surgeons in operation. The rule is, indeed, that the wen is not disturbed unless it is a source of annoyance.

Molluscum Contagiosum is a disease of the skin caused by blocking of the sebaceous glands. Tumours, similar to wens, are produced. They are filled with a milky fluid which is said to be capable of communicating the disease. They occur singly or in groups on the face, eyelids, chest, arms, and breasts of women. They are not painful. At the top of the tumour is a minute opening, through which frequently the contents of the sac may be squeezed.

Treatment.—The tumours are emptied by squeezing, after which the walls shrink so as to become flat, or they may be opened—of course only by a surgeon.

Excessive Secretion of the **Sweat Glands,** producing excess of perspiration, may occur over the whole body, as in exhausting diseases, and in weakened conditions of body after some illness, or it may be limited to parts—the armpit, hands, or feet. Parts thus affected often become very tender and painful, and a local eczema (p. 425) may be produced. In the case of the feet, the smell is very objectionable, and the term **stinking foot-sweat** has been applied.

Treatment.—The parts should be frequently washed with yellow soap and water. Into the part should be rubbed, several times a day, some of a solution made by dissolving 60 grains of tannic acid in 6 ounces of spirit. The skin should not be wiped after the application. Into the stockings of persons with sweaty feet some powdery material should be dusted--starch, lycopodium, or even common flour.

Sudamina (*Miliaria*) are small round blisters of the size of millet seeds, containing at first clear fluid, which, after twelve or twenty-four hours, becomes milky. The blisters appear like little pearls scattered about the skin. They last three or four days, then dry up, and thin scabs are thrown off The fluid they contain is sweat, and they are produced by excessive sweating. A pricking sensation is experienced in the skin when the blisters are being developed. To this affection the term **prickly heat** or **summer rash** is applied by some. It attacks in hot climates; and the troublesome prickly sensation prevents sleep during the night.

Treatment.— *Warm baths should not be used.* The skin should be kept cool and dry, and the excessive sweating avoided if possible. Over the skin some fine powder, starch, &c., may be dusted to allay the irritation.

Acne (*Face Pimples—Stonepocks*) is a chronic inflammation of the hair sacs and of their attendant sebaceous glands. It appears as small red pimples chiefly on the face, chest, and back of young persons. They often arise after the mouths of the glands have been blocked by plugs of sebaceous matter—comedones,—which the pimples surround. Sometimes the inflammation passes deeply into the skin, and the pimples extend inward as little nodules. Often matter is formed which appears on the surface of the pimple. When the matter has been discharged the nodule may disappear, but a scar is left to mark its former place. An acne pustule may be so large as to resemble a boil. The affection usually declines after the twenty-fifth year of age or so. An eruption of acne pimples may be produced in some people by the taking of iodine as medicine, or by the application to the skin of some preparation of tar. Workmen who have to work with tar or some of its products are liable to exhibit such an effect.

Treatment.—Frequent rubbing with soap and water is recommended as one of the most efficacious means of treatment, because it softens the scarf-skin and removes some of its layers, and with them plugs blocking the sebaceous glands, the cause of the affection. When the back and chest are badly affected, hot baths greatly aid the treatment. A lotion of bichloride of mercury, ½ grain to 1 ounce of water, and glycerine, is also valuable. The treatment must be steadily persevered in for a considerable time; comedones (p. 435) should be removed by pressure, and matter should always be let out.

Acne Sycosis is a form of the affection attacking hairy parts, specially the beard. Through each of the pimples or pustules a hair is seen to pass. The pimples may come out in crops so close together that patches of inflamed, thickened skin are formed, and separate pimples not noticed. The matter produced may, in such cases, form crusts, pierced also by hairs. The hairs are loosened and fall out, and when the part heals, depressed scars are left, on which hair does not again grow.

Treatment.—The hairs over the diseased part should be cut short. Warm poultices should be applied, and afterwards oil rubbed on to remove crusts. Thereafter the part should daily be gone over by a surgeon, and hairs from all affected parts pulled out with forceps. After each such procedure white zinc ointment, or chrisma sulphur, should be rubbed in. Hebra strongly advises daily shaving, not only to aid in curing the disease, but to prevent its return.

Acne Rosacea (*Gutta Rosea*) is an affection which appears on the face, specially the nose, forehead, cheeks, and chin, and is characterized by an intense reddening of the skin, without swelling. The redness is due to overfulness of the blood-vessels. They can be partially emptied by firm pressure with the finger, so that the redness disappears from the pressed part, but it returns on removal of the finger. The person experiences a sensation of warmth over the affected part, especially after a meal or in the evening. One form is confined to the nose, in which the lines of over-full vessels are readily seen, and the nose is shiny by increased fatty substance from the glands. But it may extend from the nose to the cheeks, forehead, and chin. The affected skin becomes thickened; and the nose is often considerably enlarged. Persons who indulge in alcohol to excess are liable to it. All kinds of stimulants, taken inwardly, increase the feeling of heat and the congestion of the part. When the disease has lasted for a long time nodules form on the skin, producing additional disfigurement.

The disease is most common in men after the fortieth year of life, and in women about the period of the change of life.

Treatment.—All irregularities of habits, &c., should be corrected if possible. The patient should live plainly and temperately, avoiding beer, wine, &c. Disorders of function ought to be attended to. The part should be well washed with soap and water, and then a sulphur ointment well rubbed into it at bed-time—the chrisma sulphur should be used, if obtainable. After several such applications, a few days should be allowed to elapse before repeating the process, since, at first, additional redness and removal of scarf-skin is likely to result. Instead of the ointment, a lotion composed of—

Carbonate of zinc	1 drachm,
Sulphur	1 drachm,
Glycerine	1 drachm,
Prepared calamine	2 drachms,
Rosewater, to	4 ounces,

may be dabbed on the skin with a piece of wool and allowed to dry on, after washing with soap and water and drying. A tea-spoonful of epsom salts with 15 drops tincture of steel in a tumbler of water taken in the morning aids the treatment. Other methods might be adopted by a physician.

INJURIES TO THE SKIN.

WOUNDS, BURNS, CHILBLAINS, FROSTBITE, &c.

(See Accidents and Emergencies.)

AFFECTIONS OF THE HAIR AND NAILS.

Excess of Hair (*Hirsuties*).—Hair may grow in excess over large surfaces or over small areas, as a hairy mole, sometimes producing disfigurement. The hairs may be pulled out if they are few, or may be destroyed by various applications, called depilatories, if they are many. They should not be applied without advice, as they may give rise to troublesome ulceration.

Baldness (*Alopecia*).—Baldness results as one of the changes belonging to old age, due to wasting of the skin, hair sacs, &c. It may occur as a result of some acute disease, or at an unusually early age without any such cause. In both the latter cases it is undoubtedly due to defective nourishment of the hair, owing to lessened circulation of the blood in the scalp.

Treatment for preventing loss of hair, or for loss resulting from fever, consists in means that will quicken the circulation in the scalp, such as washing the head every morning in cold water, then drying with a rough towel by vigorous rubbing, and brushing with a hard brush till the scalp becomes red. A stimulating lotion should then be well rubbed in for several minutes. Wilson's lotion is made of sweet-almond oil 1 ounce, strong liquor ammonia 1 ounce, spirits of rosemary 4 ounces, water 2 ounces.

Alopecia areata is a form of baldness which occurs in roundish patches. Probably the patches have existed for some time before they are noticed. They are smooth and white. Besides occurring on the head, they may be on eyebrows, cheeks, or other hairy parts. They tend to spread. When hair grows again on the patches it is fine, downy, and white, and it may remain white always, or at least for a long time. It is probably due to a nerve disturbance of the skin. (See Plate XXIV.)

Treatment.—The spread of the disease can be arrested by painting the part with blistering fluid. This may be repeated every two or three weeks. Frequent brushing with hard brushes, the use of electricity applied by a wire brush, and various other methods are also advised.

Grayness of Hair (*Canities*) occurs usually as a change of old age, but it may also occur in early life, and as a result of mental anxiety, shock, &c. The colour of hair is due to colouring matter developed from the papillæ from which the hair grows (p. 413). Any change of colour must begin at the papillæ. As the hair grows, the gray part advances, until hairs formerly coloured appear gray or white throughout their length. It takes, therefore, in all cases weeks, or at least days, before the change can be detected. Stimulating remedies, or electricity, as suggested above, may be employed.

Inflammation of Nails (*Onychia*) may be produced by injury, pressure, &c., and sometimes occurs because of bad general health. Redness and swelling occur round the nail, and the bed of the nail is deep red. A feeling of heat and throbbing and pain on pressure are experienced. Matter forms; discharge oozes from the fold of the skin at the root; the nail becomes loose, and there is a raw tender surface beneath it. After the old nail has been shed, the new one grows slowly and the wound heals painfully.

"Ingrowing toe-nail" produces similar symptoms, limited to the part pressed on by the nail.

Treatment. — Warm poulticing will frequently give relief. The nail is also thereby softened and readily pared. In "ingrowing toe-nail" little bundles of some soft threads, torn from lint, of the length of the nail, should be laid on the nail in line with the inflamed fold, and should be gently pushed down, thread by thread, by means of some appropriate instrument, between the border of the nail and the inflamed fold. The fold is padded with fine strips of lint, and strips of sticking-plaster are wound round the toe from above downwards. By this means the nail and fold are separated. After wearing this for a day, a warm foot-bath is taken, the lint removed, and fresh strips applied. In a few days the swelling and pain will be so reduced that one may be able to remove with scissors the side of the nail.

THE CARE OF THE SKIN, HAIR, AND NAILS.

The chief aid to a healthy skin is cleanliness. The surface cells of the scarf-skin are continually being shed or rubbed off in minute masses, which are held together by the oily fluid exuding from the sebaceous and sweat glands (p. 413). This refuse matter is apt to collect on the surface, and, if it be not removed, to irritate the skin. Moreover, the pores or channels of the glands are liable to become blocked, and the secretions to be thereby pent up. From both causes pimples, redness and blotching of the skin, especially sensitive skins, will readily result. Nor is the injury confined to the skin. It is an organ of purification, by whose means the blood ought to be cleansed from impurities. If cleanliness is not practised, this duty is improperly discharged, and the whole body may suffer in greater or less amount. Regularly some method ought to be adopted for removing the cast-off material, and the method is the bath—the use of soap and water, applied with moderately vigorous rubbing. The warm bath is undoubtedly the best for cleansing purposes, and the custom of taking a warm bath once or twice weekly is to be persevered in. But no one should come directly from a warm bath unless it is to get immediately into bed. Under any other circumstances the water ought gradually to be cooled down till it becomes lukewarm.

The cold bath is useful not only for cleansing but for its bracing and stimulating properties. When one enters a cold bath, the stimulus of the cold to the skin excites the vasomotor nerves (p. 312), and the blood-vessels of the skin become much contracted, so that the blood is driven out of the surface into the deep parts. In a short time after coming out of the cold bath the reaction should set in, the blood should rush from the deep parts to the surface, and a warm glowing sensation should be experienced. For a time the blood flows in greater quantity through the skin, and then gradually there is a return to the usual condition of affairs. The effect on the nervous system and the quickened circulation have beneficial effects on the general state of the body. Cold bathing should not be persisted in if this reaction does not rapidly occur. If the skin remains cold and bluish it is an indication against the cold bath or a warning that it has been too long persisted in. Rubbing is a great aid in hastening and ensuring reaction.

Those who would like to take a daily cold bath, but are afraid of the consequences, should set themselves to work up to it, either by taking a warm bath, and, day by day, diminishing the amount of warm water in it and increasing the cold, or by beginning with merely a rapid sponging on rising from bed, and gradually extending it till they are able to bear a regular cold bath. Friction with a wet towel or sheet may be employed to begin with.

A hot bath should range between 98° F. and 105° F., a merely warm bath not above 100°.

Soap should be used to the face as well as to other parts of the body, since nothing is so efficacious in removing the little plugs that block the mouths of the glands especially on the faces of young persons. But the soap should be thoroughly washed off, and the face bathed with cold water, before drying. Some persons, however, find soap irritating to the face. They may use instead a few drops of spirits of ammonia to the quart of water with which to cleanse the face.

Cosmetics, especially those in the shape of pastes and powders that improve the complexion by covering up the offending spots, are often liable to do serious mischief by interfering with the natural functions of the skin. The wash of bitter almonds recommended on p. 429 for freckles may be employed with safety.

In regard to the hair, too frequent washing should be avoided; and daily washing of the hair is too frequent, rendering it dry and brittle. Probably once a week is sufficient. For it, also, soap and water are the most suitable materials for cleansing. Salt of tartar, which is often put into the water, ought not to be employed. No comb or brush with sharp edges should be employed; and small-tooth combs ought not to be used. A comb should be used gently to disentangle the hair, and not to scrape the scalp, for the removal of dandruff is not aided by this means. Pomade should be employed with discretion, but only when the hair is of itself too dry. The best are those made of perfumed vaseline or chrisma, which do not become rancid.

Long hair is the better of being trimmed at the ends once every two or three weeks to prevent splitting. The practice of girls wearing short hair is one greatly to be encouraged. The crimping and plaiting of hair requisite for those who wear it long is injurious, and is likely to lead to weakness and thinning especially at the parts where the greatest strain is exerted, very often the very front of the head.

Hair-dyes consist as a rule of a salt of lead or silver. Both are injurious, the former much more so than the latter, and all should be avoided. The idea conveyed in the term "Hair-Restorer," that a chemical preparation will restore colour to the hair without dying it, is a delusion.

Nails should be cleansed with soap and water applied by a brush. A knife should not be employed to remove dirt from under the free edge, since it scratches the nail, and foreign matter getting into the scratch will be removed with difficulty. The brush is, therefore, the best agent. Nails should not be so far cut, when being trimmed, as to prevent them affording protection to the finger-tips. The soft prolongation from the surface of the skin on to the back of the nail at the root ought to be kept down by using an ivory presser, and not by means of a knife. If it is allowed to grow it becomes rugged and unsightly, and also painful by being torn and bleeding.

The hands require frequent washing. Those persons the skin of whose hands is dry and harsh will derive benefit from rubbing with glycerine or vaseline. The use of the same substances will prevent hacks in the skin, which, if not attended to, may become extremely painful.

The feet require as much attention as, indeed more than, the hands. They also should be frequently washed with soap and water, and the nails trimmed. They should not be pinched up in narrow boots. The boots ought to have broad low heels, and ought to be broad enough in front to give the toes freedom. Those who are troubled with blistered feet after walking any considerable distance will find great benefit from rubbing some soft soap over the inner surface of the stocking in contact with the parts usually inflamed.

SECTION XXII.

THE SENSES AND SENSE-ORGANS.

THEIR STRUCTURE AND FUNCTIONS (ANATOMY AND PHYSIOLOGY).

The Conditions of Sensation:
- *Terminal organs;*
- *Fusion of Impressions.*

Touch.

The Organ of Touch:
- *Pacinian Corpuscles* and *Touch-bodies.*

The Sense of Touch:
- *The sense of contact*—Aristotle's experiment;
- *The sense of pressure;*
- *The sense of temperature.*

Taste.

The Organ of Taste:
- *The Papillæ (filiform, fungiform, and circumvallate) of the tongue;*
- *Taste-bodies*—The nerves of taste.

The Sense of Taste:
- *Difference between taste and flavour.*

Smell.

The Organ of Smell:
- *The Nostrils and their lining membrane* (Schneiderian)—Nerves of Smell.

The Sense of Smell:
- *How excited*—Its acuteness.

Sight.

The Organ of Sight (the Eye and its Appendages):
- *The Orbit;*
- *The Eyelids*—their glands (*meibomian*) and lining membrane (*conjunctiva*);
- *The tear-gland and passages*—the explanation of weeping:
- *The Eyeball*—Its sclerotic and choroid coats—Its chambers—The pupil of the eye—Its lens—Its nervous coat (*retina*).

The Sense of Sight:
- *The perception of light*—the blind spot—the yellow spot;
- *The perception of objects*—Comparison between the eyeball and a photographer's camera;
- *The accommodation of the eye to different distances;*
- *Normal sight, short sight, and long sight;*
- *The movements of the eyeball*—The muscles of the eyeball—squinting;
- *The information gained by the eyes*—Floating specks before the eyes—Purkinje's figures—Hallucinations—Estimate of size and distance by the eye;
- *Single Vision with two eyes*—The stereoscope;

The Sense of Colour:
- *Fundamental and Complementary colours;*
- *The perception of colour;*
- *After-images.*

Hearing.

The Nature of Sound:
- *Musical sounds*—On what their loudness, pitch, and quality depend.

The Organ of Hearing (the Ear):
- *The outer ear*—The auricle and external canal;
- *The middle ear*—The drum of the ear—The Eustachian tube—The small bones of the middle ear;
- *The internal ear*—The semicircular canals, and cochlea—Corti's organ.

The Sense of Hearing:
- *The perception of sound*—Sympathetic vibration;
- *The range of the ear;*
- *The sensation of discord;*
- *Judgments formed by the ear.*

The Conditions of Sensation.—The senses are the avenues by means of which information reaches the individual regarding the condition of his own body, and concerning the outward world which surrounds him, and of the manner in which it affects him. Every living being, even the humblest, is not a mere separate existence, having a life of its own and independent of everything else; it is a part of a greater existence; and its value is estimated by the nature of the relations it bears to that great world of things of which it is but a mere speck. The most elementary living things have no nervous system, no special apparatus for communicating outwardly. They are little masses of irritable jelly-like living material (protoplasm), capable of acting as a whole, and with no part of their substance devoted to special purposes. An advance in this structure is perceived when a living thing shows evidence of having one part of its body devoted to the discharge of one duty and another part to the performance of another duty. The rudiments of a nervous system are found in some of the lowest animals, where one cell readily affected by certain agencies—contact with foreign material, for example—is situated near the surface of the body and communicates by a slender thread with a cell, capable of contracting, placed deeply in the body. Whenever the cell on the surface is affected sufficiently, the irritation of its substance that results is communicated along the thread to the deep cell, and excites it to contract, so that the body of the organism is moved. One cell is, as it were, on the look-out, and the business of the other one is to act on receiving information. Such a simple arrangement is sufficient for an elementary organism. But animals higher in the scale are affected in so many different ways by so many different agencies that a further subdivision of labour becomes necessary. One man may be a sufficient watch on the top of a small fort, but a large town needs a multitude of watchmen, each with his own particular duty and his own special post. So in the higher animals and man certain organs are set apart to give information regarding things the body comes in contact with, their hardness, their degree of heat, &c., all that is included under the sense of touch; another organ is set apart to give information about smell, another to inform regarding taste; another organ has as its business the duty of being on the look-out for light and colour, another for taking knowledge of sounds. The senses are thus the outposts of the mind, disposed along its walls to take note of and report to head-quarters anything that comes within the range of their duty. Without them man could have no knowledge of the outward world and could hold no relations with it. The information they supply acts, in great measure, as the motives and bases of his action. It is not out of place to remark how great, then, is the need of the information being accurate, and of the outposts being properly trained to their work, lest they mislead the mind!

There are thus a number of **special sensations**, touch, taste, smell, seeing, hearing, to which is added the muscular sense, by means of which information is supplied regarding outward things and forces. Besides these, however, there are a number of **common or general sensations**, the need of which arises from the highly complicated structure of the higher animals. The feature of such higher animals is the multitude of different organs in the body, each performing its own part of the general work required for maintaining the life and vigour of the animal. These organs must all work in harmony, and are in communication with one another. It is necessary that the individual should have some means of knowing whether the harmony is being maintained, and should have some warning if any organ is doing bad or indifferent work. Such information is supplied by common sensations. Thus a feeling of comfort informs of general well-being; a feeling of hunger or thirst informs of the need of certain substances to maintain nourishment; a sense of discomfort informs of some disturbance, and so on.

The essentials of a sense organ are well shown in the rudimentary forms of a nervous system, where there exists (1) one cell whose business it is to receive the impression, and (2) a nerve thread to carry the impression to (3) a cell whose business it is to receive the impression and take knowledge of it in some way or other. These three elements are necessary for a sensation.

(1) There is a special structure adapted for being affected by a particular kind of influence. Thus the eye is an organ specially formed for being stimulated by the action of light, while the ear is uninfluenced by light but is stimulated by the waves of sound, and so on. The special structures are called **terminal organs**.

From the special structure, whatever it may be, (2) a nerve proceeds which is in direct communication with

(3) Nerve-cells in the brain in the region of consciousness. This last is important to notice. The nerve-centre to which the impression, made on the terminal organ, is conveyed by the nerve, must be situated in the brain, if the impression is to give rise to a sensation.

Suppose the impression for some reason or other is arrested in the spinal cord, no sensation will result. Thus the nervous chain necessary for a sensation is not identical with that described on p. 132 as necessary for a reflex action. A man who has had his spine injured, and is thus paralysed in both legs, does not feel a severe pinch of the skin of either leg, but probably the pinch causes the leg to be spasmodically jerked. An impression has been made on the skin, which has been transmitted to a nerve-centre. But the nerve-centre is in the cord. The injury to the spine has prevented the impression being conveyed up the cord to higher centres in the brain. Thus, though the impression has been quite sufficient so to stimulate a nerve-centre in the cord as to produce a marked reflex act, the man has been unaware of the pinch; he has had no sensation. A sensation, then, cannot be produced unless the influence has been transmitted to a higher centre in the brain, and has there excited a change of which the individual becomes aware. An impression may be duly made upon a terminal organ, but it cannot properly be called a sensation until the person becomes conscious of it. *A sensation may therefore be defined as the consciousness of an impression.*

Now, if this is understood, it is easy to perceive that a sensation may be abolished in various ways. Take, as an example, the sense of sight. A person may be blind, as we all know, because of some injury or disease of the eye, because, that is, of something-wrong with the terminal organ; but that is not the only way blindness may be produced. Another person might have perfect eyes, and yet have no sight. The nerve leading from the eye to the brain, the chain of communication, might be interfered with, destroyed, for example, by the pressure of a tumour, and, therefore, though light duly fell upon the eye and produced there its wonted effect, no knowledge of it would exist because of the rupture of communication —the impression could not be conveyed to the brain. In a third way a person might be prevented from seeing. Suppose the eye and its nerve unaffected, but the centre in the brain destroyed by the progress of some disease, the impression duly made on the terminal organ and carried along the nerve would reach a disorganized centre, which could not receive it, and no consciousness of sight would arise.

But there are instances of failure to see, illustrating well the necessity for activity of the centre, not dependent upon any disease. Lift the eyelid of a sleeping man, and hold a lighted candle in front of the eye; an image of the candle flame is properly formed on the back of the eye, an impression is duly conveyed along the nerve to the centre, but the centre slumbers and there is no conscious sight. A man is walking through the streets engrossed in thinking over something; a friend walks straight towards him, and the person is apparently looking directly at his friend, but does not notice him and would pass on did his friend permit. His friend's face and figure made their usual impression on the eye, which was properly transmitted to the conscious centre, but that centre was already occupied, and the impression failed to arouse a consciousness of its presence. The same facts might be illustrated in connection with any other sense, but enough has probably been already said to show what are, in general, the conditions of any sensation.

Sensation, then, is the result of a change occurring in a centre in the brain, and yet when the skin is pinched we refer the impression to the skin, though it is in the brain that it is actually perceived. We think it is our ears that recognize sounds; in reality it is only the brain that takes note of them as such. This habit of referring the sensation to the terminal organ which first received the impression is the result of education and habit. When we see a light, what we are conscious of is a change in a brain-centre, and yet we refer it outwardly. If the optic nerve be irritated by a current of electricity, or by a blow, we see flashes of light as vivid as if lights actually danced before our eyes. Impressions have reached the centres for seeing, coming along the ordinary channels, and produce the same changes that lights should do. In this case, however, we know the cause of the colours, and correct the conclusion we would otherwise make. The seeing centre itself may be irregularly stimulated, by some condition of the blood, for example, and the person may see things which appear as real as if they were actual external existences, but which have only a temporary existence in his disturbed brain. Thus the man in *delirium tremens* sees fantastic figures dancing and making grotesque faces at him. His seeing centres, excited in an unhealthy way by alcohol, are of themselves producing changes which, in healthy circumstances, ought only to be aroused by real things external to him. The changes in the brain have, in this case, nothing corresponding to them outside, but the brain, nevertheless, refers them to the outside as usual, and they, therefore, appear to be real things. The man's judgment being otherwise also warped by the alcohol, he cannot correct his impressions, and is consequently victimized by them.

Fusion of impressions.—It is a feature of all the senses that when they are excited by a series of impressions, in which one follows the other very quickly, they are unable to distinguish the different impressions. The series become fused together, and the sensation is of a prolonged impression. Thus, if the finger be gently pressed on the edge of a toothed wheel, with the wheel going very slowly, the contact of each separate tooth is distinctly felt; but when the wheel is made to turn rapidly one loses the sensation of the separate teeth, and the feeling is of an uninterrupted kind. Again, every child knows that if a piece of string, which has been on fire at one end, be whirled rapidly in the air, the appearance of a wheel of fire is produced. The one point of fire becomes a circle. This sensation is produced by a rapid series of impressions. From every point of the circle described by the glowing end of the string, from point after point of it in quick succession, an impression reaches the eye of the glowing point as it travels round. But all the different impressions follow so hard after one another that they are not separately distinguished in the mind, which thus becomes conscious of a continuous circle of light (p. 451). It is the same with sound. If an instrument be made slowly to emit a series of sounds, each sound of the series may be recognized separately; but if they be produced with a certain rate of rapidity, one sound is heard before the one preceding has died out, and a continuous instead of an interrupted sound is heard.

Now the explanation of this fusion of impressions is the same for all the senses. It is that the sensation lasts longer than the stimulus producing it. A flash of light in the darkness may last for a very small fraction of a second, but the effect on the eye does not vanish with the flash. It continues for a very brief space of time longer, and if a second flash be produced it may again excite the eye before the first impression has faded, and so the two become blended. Most people have noticed that if a shrill sound, say a railway whistle, has been prolonged for some time, they are doubtful of the exact moment when it ceased. The sound appears to ring in their ears some seconds after it actually stopped. If it had begun again before the ringing had left their ears, probably many would not observe that it had stopped for an instant. It would seem to have only become feebler for the moment.

TOUCH.

THE ORGAN OF TOUCH.

The organ of touch is situated in the skin throughout its whole extent, and in the mucous membrane of the mouth and nostrils. On p. 412 the structure of the skin is described, and the two layers of which it consists are noted. It is only in the deep layer that blood-vessels and nerves are found. The nerves terminate in many cases in a peculiar way. In many of the papillæ or ridges into which the true skin is thrown (Fig. 164, p. 412) are oval-shaped bodies about the $\frac{1}{300}$th of an inch long, formed apparently of layers of fibrous tissue. A nerve-fibre winds round this body and finally enters it. These are called **touch-bodies** or **tactile corpuscles**, and are found in the skin of fingers and toes. In the tissue under the skin of the hand and foot of man are other bodies, called **Pacinian corpuscles**, larger than touch-bodies, the largest being $\frac{1}{20}$th of an inch long. Each one is placed on the end of a nerve-fibre, which is like a stalk to it, the fibre passing directly into the centre of the corpuscle. Besides these two special forms of nerve-endings in the skin, there are the simple terminations of the nerve-fibres in the form of a net-work in the upper part of the true skin. In all cases the nerve-endings never reach the surface. Any impression must be communicated to them through the cellular layers of the scarf-skin.

THE SENSE OF TOUCH.

The sense of touch is aroused by stimulation of the nerve terminations, already described, either by mechanical means or by heat or cold. When we lay our hand on anything, the mere mechanical contact with the body produces a sensation of touch, and if the body be warmer or colder than the hand a sense of heat or cold is aroused. Touch includes three things: (1) the sense of contact, (2) the sense of pressure, (3) the sense of heat and cold.

(1) **The sense of contact** is the most important element in touch. By it we gain information as to the form, size, and other characters, smoothness, hardness, &c., of external bodies. The sensitiveness of touch varies in different parts of the skin. Where the scarf-skin (epidermis) is thinnest it is most acute; where it is thickest it is more dull. The absence of epidermis altogether does not render the part more sensitive to sensations of contact. The direct contact with the unprotected true skin occasions pain, which effectually masks the feeling of contact. The tips of the fingers, the red border of the lips, and the tip of the tongue are the most sensitive parts. Experiments have been made on the degree of sensibility of various parts to touch, by using a pair of compasses, with points blunted by pointed pieces of cork, and determining how much the compasses required to be open for the impression of each point to be felt. If the two points were very near, the sensation was of one point only, and in order to produce the sensation of two points the ends of the compasses had to be separated by varying distances according to the part of the skin experimented on. The result showed that two points could be distinguished by the tip of the tongue though they were only $\frac{1}{24}$th of an inch apart, by the tip of the forefinger if $\frac{1}{12}$th of an inch apart, by the red surface of the under-lip if

$\frac{1}{6}$th of an inch apart, by the tip of the nose when $\frac{1}{4}$th inch apart, by the palm of the hand if $\frac{5}{12}$ths inch apart; and that the points of the compasses required to be separated $1\frac{1}{6}$ inch to be perceived as two when placed on the back of the hand, while in the middle of the thigh they required to be separated $2\frac{1}{2}$ inches.

(2) **The sense of pressure** is different from the sense of contact, for sometimes those parts which are less acute for mere sensations of touch are more correct in gauging pressures. It is by the sense of pressure that we estimate differences of weights. Another element is introduced, however, in judging of weight, when the weight is taken in the hand, and the hand moved up and down. The weight offers resistance which the muscles require to overcome, and this calls forth what has been called a **muscle sense**, a sensation produced by the muscles, caused by the resistance offered to their movement.

(3) **The sense of temperature.**—The skin also judges of heat and cold, but its judgments are in this case liable to serious error. If one hand be very cold and the other very warm, and both be placed in the same basin of tepid water, the warmth of the water will be very different to each hand. To the warm hand it will appear cold, and to the cold hand warm. We cannot, therefore, judge absolutely of temperature. Then, again, the thickness of the scarf-skin seems to affect the sensitiveness to heat, for parts with thin epidermis can bear less heat than parts with thick epidermis.

Pain is an excessive stimulation of the sensory nerves, and in it all finer sensations are lost. Pain at once takes the place of other sensations, whether of contact or of pressure or of temperature, at that part of the skin so deprived of the epidermis as to lay bare the true skin.

The sense of touch supplies information according to the degree of its education. A common instance of this is the use of the blind alphabet—in reading by the fingers. An untrained person cannot distinguish the form of the raised letters; all is to him confused and indistinguishable. We all know how persons who have been born, or have early become blind, train their sense of touch to supply them with much of the information they would otherwise gain by sight.

A curious illusion of contact is shown in an experiment of Aristotle's. Place a marble between two fingers, so that it touches one side of one finger and the other side of the other finger. There is the sensation of one marble. Now cross the one finger over the other so that the marble is supported by the other sides of the two fingers, the sides not opposed to one another, and roll the marble between the two fingers, the impression of two marbles will be received, more particularly if the eyes are shut. Probably this is the result of habit, for the two surfaces of the fingers could never make contact with one object, unless the fingers were crossed in this unnatural way. Usually an impression on each surface at the same time would arise from two different bodies, and as this has always been the case the habitual impression is aroused even when, by crossing the fingers, one body is made to touch both surfaces at the same time.

TASTE.

THE ORGAN OF TASTE.

The Tongue and Soft Palate are the seat of the organ of taste, which consists, like that of touch, in a particular mode of nerve termination. The tongue is composed mainly of muscular fibres running in various directions, and freely supplied by nerves and vessels. It is covered by mucous membrane similar to that lining the mouth, which contains glands in the deeper layers. The surface of the mucous membrane is thrown into irregular projections, called papillæ, of various forms. The **filiform papillæ** are very short, fine, hair-like processes, which are exceedingly numerous over the whole surface. The **fungiform papillæ** are broader and mushroom-shaped, and are scattered over the surface. They often project as red points when the rest of the tongue is white and furred. The **circumvallate papillæ** are the largest of all, and the least numerous. They are so called because consisting of a fungiform papilla surrounded by a fold of the mucous membrane. They present the appearance of being walled round. They are found near the back of the tongue, being ranged in two lines, passing from a point in the centre of the surface towards the sides. There are only about a dozen of them altogether. The papillæ all contain twigs of vessels and branches of nerves, and are covered by epithelial cells. In the circumvallate papillæ are peculiar structures called taste buds. Fig. 171 shows a section of such a papilla, in which A is the centre and B B sections of the surrounding fold. A trench is seen to separate the centre from the surrounding fold, and at the sides of the central papillæ, in the deep parts of the trench, are a number of flask-shaped bodies (T T). These are the taste buds. They are formed of stave-like epithelial cells, represented in II of the figure. In the inside of the buds are finer cells, represented at III. The mouths of the buds open into the trench. The taste bodies are connected with nerve-fibres, and it is supposed they are peculiar adaptations of epithelium, readily excited by sapid substances and transmitting the impression along the connected nerve.

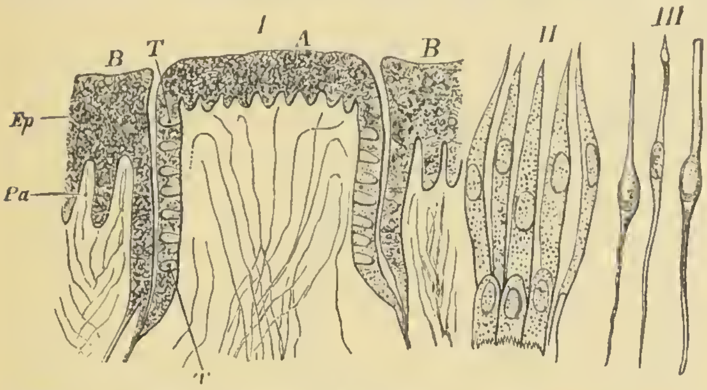

Fig. 171.—Section of Circumvallate Papillæ of the Tongue—highly magnified.

I A, Section of the central papilla. B B, Section of the surrounding elevation. Pa, Papilla of the true skin. Ep, Layer of cells—epithelium. T, Taste Buds. II and III represent very highly magnified views of cells of the taste buds.

The tongue is supplied with sensory fibres by two nerves, the glosso-pharyngeal, a branch of the eighth cranial nerve (p. 152), and a branch of the fifth cranial nerve (p. 151)—the gustatory branch. The former confers taste on the back part, and the latter on the front part of the tongue. Branches of the former also pass to the soft palate and neighbouring parts, and confer taste on it.

THE SENSE OF TASTE.

The sense of taste is excited by stimulation of the mucous membrane of the tongue and palate affecting the terminations of the nerve-fibres and causing impressions to be transmitted to the brain. The stimulation seems to be a chemical one; and the substances must be in solution to produce taste. A dry condition of the mouth is not favourable to taste, and powders are not tasted till dissolved by the juices of the mouth. Various kinds of substances are capable of producing the stimulus, acid substances, alkaline and saline substances do so. Acid tastes are perceived by the fore part of the tongue, bitters by the back part and not by the fore part. Sweet and salt tastes are perceived by both. Stimulation of the nerves, for example by electricity, and without the presence of any tasty body, will excite sensations of taste. The nerve-centre for taste receives an impression transmitted by the nerve, and has no means of distinguishing between such impressions and others excited in a regular way. Similarly morbid conditions of the body may excite sensations of taste.

The taste of many substances is got rid of with difficulty. This may be due to the extreme sensibility of the nerve terminations to some substances. Thus 1 part of sulphuric acid in 1000 parts of water will be detected by the taste, and it may be that the taste remaining in the mouth is due to traces of the substance. Like other senses, that of taste may become fatigued. Repeated tasting of one substance rapidly deadens the sensibility, probably because of over-stimulation.

The sense of **flavour** is something more than taste. Flavour is a conjunction of both smell and taste. Thus, if the eyes of a person be blindfolded, and the nostrils firmly held, the person will be unable to distinguish between an apple and an onion, if one be rubbed on the tongue after the other. As soon as the nostrils are open the difference is perceived. In a similar way a common cold, causing blocking of the nose, interferes with the sense of flavour, as it abolishes smell.

SMELL.

THE ORGAN OF SMELL.

The Nostrils contain in their mucous membrane the structures devoted to the sense of smell. Reference to Fig. 12, p. 59, shows the cavity of the nostrils so far as formed by bone. The roof of the cavity is formed by the ethmoid bone, the upper surface of which forms part of the floor of the brain cavity, so that this horizontal plate above separates the brain cavity from the cavity of the nostrils. Part of the side walls of the nostrils, as low as the floor of the cavities for the eye (see p. 59), are formed by light scroll-like prolongations of the same ethmoid bone, the remainder of the side walls being formed of part of the upper jaw-bone. A central perpendicular plate of the ethmoid divides the upper part of the cavity into a right and left portion, and this division is continued downwards by the ploughshare bone (p. 60), and completed by gristle. The bony palate forms the floor of the nostrils. There is an opening to each nostril behind, into the back part of the throat, as well as in front. The walls of the cavities are lined by mucous membrane, richly supplied by vessels and nerves. The nervous distribution is shown in Fig. 172, where branches of the fifth cranial nerve are seen traversing the cavity and passing over its walls. The nerves of smell proper are, however, shown spreading in a thick brush over the upper and middle scroll-like bones of the outer wall, and over the upper part of the inner wall. They are found in the mucous membrane. These nerve-fibres are derived from the first pair of cranial nerves—the olfactory (p. 151), which rest on the upper surface of the ethmoid bone, and send branches through openings in its horizontal plate, which, because of the many perforations in it, is called the **cribriform** plate. The terminations of these nerve-fibres seem to be connected with epithelial cells lining the surface of the mucous membrane. The membrane is called the **Schneiderian membrane.**

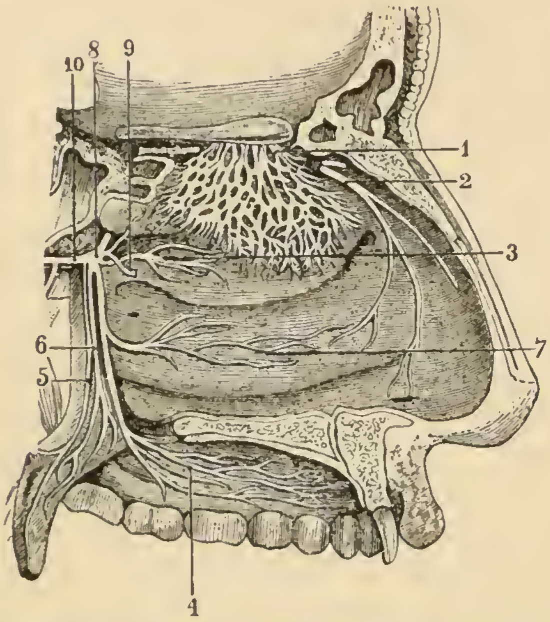

Fig. 172.—Distribution of Nerves over interior of Nostrils, outer wall.

1, Branches of nerves of smell—olfactory nerve. 2, Nerves of common sensation to the nostril. 4, 5, 6, Nerves to the palate springing from a ganglion at 3. 7, 8, 9, Branches from one of the palate nerves to nostrils.

THE SENSE OF SMELL.

The Sense of Smell is excited by the contact of particles contained in the air with the terminations of the fibres of the nerve of smell. But these, as we have seen, exist in the upper parts of the nasal cavities. In ordinary quiet breathing the air passes through the lower part of the nasal cavity, and the air in the upper regions is barely disturbed. If few of the odour-bearing particles are in the air, they may never reach the true olfactory region, and no smell will be felt. In such a case if a sudden sniff is made the air is forcibly drawn into the nostrils, passes up even into the upper chamber, and thus a faint smell becomes readily perceived.

The sense of smell is extremely acute. According to Valentin $\frac{3}{1000000000}$ of a grain of musk can be distinctly smelt. Like taste, the sense of smell becomes readily fatigued. Thus, after remaining a time in an atmosphere whose smell appears strong when we first enter it, we gradually fail to perceive the odour, and it is only when we have passed out again to the fresh air that we again perceive the difference. Smell is related to taste in the perception of flavours, as already noted under Taste. The swelling of the lining membrane of the nostrils caused by a cold abolishes smell, probably both by preventing the entrance of air to the upper parts of the chambers, and by burying and obscuring for a time the terminations of the nervous filaments.

Sensations of smell may be excited by stimulation of the centres for smelling in the brain, owing to some abnormal condition and not due to impressions produced on the terminal organ by any odoriferous particles.

SIGHT.

THE ORGAN OF VISION—THE EYE AND ITS APPENDAGES.

The Orbit.—The eyeball is situated in a bony cavity called the orbit, formed by various bones of the head and face (see p. 59). The cavity is padded by a loose fatty tissue, the diminution in the amount of which aids in producing a sunken appearance of the eyes.

The Eyelids are formed of folds of skin, the outer surface having the structure of ordinary skin, the inner of mucous membrane. In the body of the lids is a layer of condensed fibrous material which maintains the shape of the lids. Nearer the inner than the outer surface of the lids is a row of glands which open on the free edge of the lid and pass from there into the eyelid in a vertical direction. These are the **Meibomian glands.** The blocking of one of these glands by the material it itself produces leads to the formation of a stye. Towards the front of the free edge of the lids are the eyelashes, which are thick and capable of rapid growth, so that if one falls or is pulled out another quickly grows in its place. The inner lining membrane of the lids is very richly supplied with vessels and nerves. The membrane is called the **conjunctiva**. It is continuous with the skin at the free edge. After lining the inner surface of the lid it passes over on to the eyeball. In ordinary inflammation from cold it is this membrane, whose blood-vessels are engorged with blood, that is the seat of the redness and swelling, and it is because it continues forwards over the eyeball that the eye has its bloodshot appearance in such cases. Such inflammation is called **conjunctivitis**.

In the eyelids are muscular fibres which close the lids by their contraction.

The tear-gland (lachrymal gland) and passages. Situated outside of the eyeball among the loose fatty tissue of the orbit in its upper and outer corner is the lachrymal gland. From it several little channels lead which open on the inner surface of the upper lid. The fluid produced in the gland passes out by these openings and flows over the eyeball. It is ordinarily just in sufficient quantity to keep the eyeball and lids moist, to wash off dust, &c. Having flowed over the eyeball the fluid collects at the inner angle of the lids. At this place in each lid is a little projecting point (**punctum lachrymalium**) in the centre of which is an opening. The openings communicate each with a small canal in the lid, which passes to the angle between the orbit and bridge of the nose, where is lodged a little sac—the **lachrymal sac**. The canal of both upper and lower lids joins this sac, and from it there passes a channel—the **nasal duct**, lodged in a canal in the bone, which leads into the lower part of the nostril. The fluid which has flowed over the eye is carried off by the canals and drained into the nose. The lining membrane of the eyelids is continuous through these canals with that of the nostrils, and thus redness and swelling of the nasal membrane, caused by cold, are apt to pass upwards and inflame the eyelids. The canals are often blocked by inflammation, and the fluid collects in the corners of the eyelids and flows over on to the cheeks.

The secretion of the lachrymal gland is under the control of the nervous system. Anything that irritates the eyelid leads to stimulation of sensory nerves, the impression passes to a nerve-centre in the base of the brain, from which nervous impulses travel to the gland leading to increased flow of its secretion. The first act in the process may be the excitement of sensory nerves in the nostril, as by the smelling of pungent salts. The stimulation of the same nerve-centre results, with its consequences of increased flow. A mental emotion, joy or grief, may stimulate the centre and produce similar results. In such cases the fluid is produced in such quantity that it cannot escape by the lachrymal canals quickly enough, and the excess rolls over the cheeks as tears. This is the explanation of weeping. Some people are "dry-eyed" in times of deep grief or other emotion. The explanation of this is as simple. The nervous influence acts on the centre in a precisely opposite way, so that instead of it stimulating the flow of blood through the gland and otherwise exciting increased activity, the nervous impression arrests the activity, so that less fluid than usual is produced. In a similar way the emotion which produces blushing in one man leads to pallor in another. In the former case the nature of the nervous effect is to permit a greatly increased flow of blood through the vessels of the face, and therefore redness of the surface, in the latter case it diminishes the natural flow, therefore there is less blood in the part and consequently less colour.

The Eyeball is a globular chamber. Its walls consist of several layers. The outermost layer is called the **sclerotic**, is a tough fibrous coat formed for protection and maintaining the shape of the ball, and is thicker behind than in front. This coat is white in appearance, and is the part easily visible to which the phrase "white of the eye" is applied. In the very front of the globe the sclerotic is abruptly transformed into a transparent portion which is circular and which forms a window through which one can see into the interior. This is the **cornea**. The sclerotic is supplied with vessels and nerves, but the cornea, though containing nerves, has no blood-vessels. It is composed of layers of fibres with numerous minute spaces between them, in which little masses of protoplasm lie. The masses send off numerous processes which communicate with one another, so that the substance of the cornea is traversed by fine threads of protoplasm connected with masses. No doubt by this living material, in lieu of vessels, the nourishment of the cornea is maintained without its transparency being interfered with. The visible part of the white of the eye is covered, as already noted, by the delicate membrane, the conjunctiva, reflected from the inner surface of the lids. This membrane has the structure of mucous membrane, fibrous tissue covered by layers of epithelial cells. But when the conjunctiva reaches the cornea, only its epithelial layers are continued over the cornea. In inflammation of the cornea blood-vessels rapidly shoot into its substance from the conjunctiva around.

Lining the inner surface of the sclerotic is the second coat of the eyeball—the **choroid**. This is essentially the blood-vessel coat of the eyeball. It contains a multitude of small arteries and veins whose connecting capillaries form a very close net-work. Connective tissue surrounds the vessels, and in the tissue are branched cells so loaded with colouring matter as to be quite black. Their appearance is shown in Fig. 173. The front part of the choroid terminates about the place where the sclerotic passes into the cornea in a series of ridges, the **ciliary processes**. The circular space thus left in front by the termination of the choroid is occupied by the **iris**, a round curtain, the structure seen through the cornea, differently coloured in different individuals. In its centre is a round hole, the **pupil**, which appears as if it were a black spot. The margin of the iris is connected firmly with the eyeball all round, at the line of junction of the sclerotic and cornea.

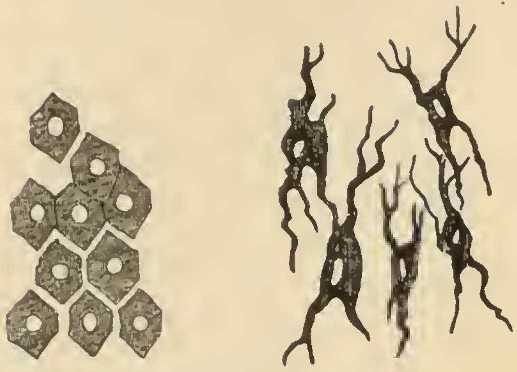

Fig. 173.—Different Kinds of Pigment Cells from Choroid Coat of the Eye.

The **iris** forms a sort of transverse partition dividing the cavity of the eyeball into two chambers, a small **anterior chamber**, extending from the front part of the iris to the back part of the cornea, filled with the **aqueous humour**, a fluid consisting almost entirely of water with a very small quantity of saline material in solution, and a large **posterior chamber**, filled with **vitreous humour**, a kind of fine transparent, colourless jelly. The iris consists of a framework of connective tissue, and its posterior surface is lined by cells containing pigment which gives the colour to the eye. In its substance are bundles of involuntary muscular fibres, one set being arranged in a ring round the margin of the pupil, the other set radiating from the pupil like the spokes of a wheel. When the circular fibres contract the pupil is made smaller, but if these fibres relax the radiating fibres cause the pupil to dilate more or less widely. The object of this will be seen hereafter.

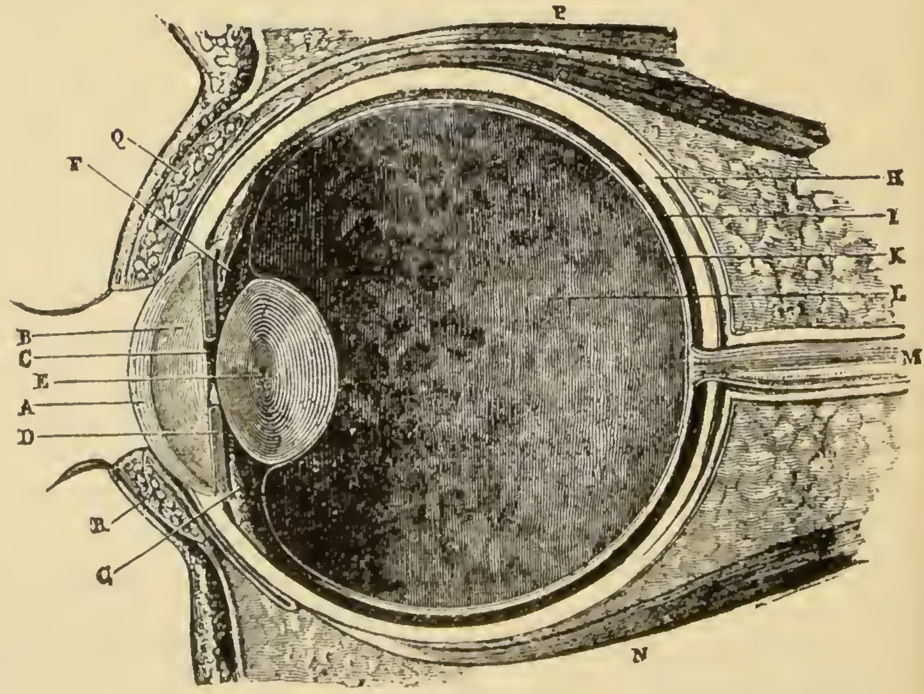

Fig. 174.—Representation of a vertical cut through the Eyeball in its Socket. For description see text

Just behind the pupil is the **crystalline lens**, resembling a small, very strongly magnifying glass, convex on each side, though more so behind. It is perfectly transparent in the healthy state. The front face of the lens is quite close up to the curtain of the eye, and the vitreous humour, occupying the posterior chamber, is closely in contact with its back face. But the lens is not loosely placed in the eyeball; it is inclosed in a capsule, the **suspensory ligament**, which not only retains it in position, but is capable of altering its shape. For the lens is elastic, its capsule is connected with the ciliary processes, and is kept usually tense, so that the lens is flattened somewhat by the pressure exerted on it. But all round the edge where the cornea, sclerotic, and choroid meet is a ring of involuntary muscular fibres, forming the **ciliary muscle**. When this muscle contracts it pulls forwards the attachment of the suspensory ligament of the lens, whose pressure on the lens is consequently diminished, and the elasticity of the lens causes it at once to bulge forwards, and become thereby more convex. The value of this movement will be understood immediately.

Reference to Fig. 174 will render the position of the parts already described more intelligible. It represents the eye lying in its socket, partly covered by the eyelids, and completely opened up by a cut from front to back. In the figure muscles (P, N) of the eyeball are shown, and a meibomian gland opened up (Q, R) is represented in each lid. A is the cornea which, at the place across which the lines from F and G pass, joins the white sclerotic (H). The cornea closes the front of the anterior chamber (B), which is filled with aqueous humour, and the back wall of which is formed by the curtain of the iris (D). In the middle of the back wall is the opening of the pupil (C), through which is seen the lens (E). F and G point to the region of the ciliary muscle and ciliary processes, the forward termination of the choroid coat (F). Behind the lens is the posterior chamber (L), filled with vitreous humour.

Our description is not yet complete, however. The eyeball, at least the posterior chamber, has an innermost lining, called the **retina** (K). The **retina** lines nearly the whole of the inner surface of the posterior chamber, lying on the choroid coat. It is, consequently, with the retina that the vitreous humour is in contact. The retina is the nervous coat of the eye; it really forms the terminal organ (p. 441) of the sense of sight. It is a very thin, soft, white membrane. If the fresh eye of a sheep or ox be opened, and the jelly-like vitreous humour removed, the retina will be seen and easily separated as a pulpy membrane from the dark coloured choroid on which it rests. But it does not separate completely. At one spot it is bound down. This spot is the entrance of the **optic nerve**. The nerve (M) comes from the brain (p. 95) and pierces the eyeball at the back, not quite at the middle, but about $\frac{1}{10}$th of an inch to the inner side, the nose side. The fibres of the nerve are distributed in the retina. The retina does not extend quite to the front limits of the posterior chamber, but stops short, in a scalloped border, the **ora serrata**, a little way behind the ciliary processes.

Though the retina is extremely delicate, its structure is very complicated. If a piece of the retina, representing its whole thickness, is examined under a microscope it shows a structure exhibited in detail in Fig. 175. The part resting on the choroid coat consists of six-sided granular nucleated cells filled with colouring matter (Fig. 173). Outside of that is a layer called **Jacob's membrane**, containing bodies termed **rods and cones**. To this succeeds a layer of nuclear bodies developed in fibres continued from the rods and cones. Outside of these a granular layer, and other nuclear bodies, &c., as represented in Fig. 175. The two layers nearest the surface of the retina, nearest the vitreous humour, therefore, are a layer of nerve-cells and nerve-fibres. In the retina vessels ramify in the region between the inner granular layer and the surface next the vitreous. The vessels are branches of the artery that enters in the substance of the optic nerve.

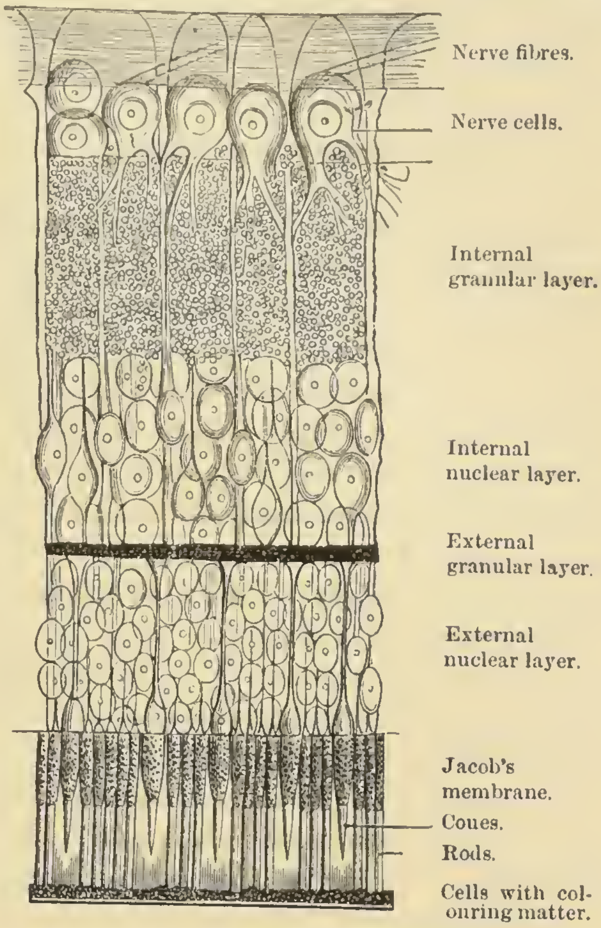

Fig. 175.—The Microscopic Structure of the Retina.

At the entrance of the optic nerve the retina contains no rods or cones. In the retina at a point exactly in the middle of the back wall, therefore directly opposite the centre of the pupil, (about $\frac{1}{10}$th of an inch to the outer side of the optic nerve entrance), there is a yellowish spot of an oval shape, the **macula lutea**, or **yellow spot** of Soemmering, which exhibits a central depression. At this part the retina is very thin, all the layers being very much diminished in thickness, except that of the rods and cones, the layer of nerve-fibres being absent. In the layer of rods and cones marked differences from other parts also exist, for rods are scarce and cones are very close and numerous.

The rods and cones are to be regarded as the peculiar modes of termination of the nervous filaments in the eye, just as the taste buds are the modes of termination of the nerve of taste in the tongue (p. 445), just as the touch-bodies are the terminations of the nerves in the skin (p. 443), and just as epithelial cells of a peculiar shape form the terminations of the nerves of smell in the nostrils.

THE SENSE OF SIGHT.

The Perception of Light.—The agent that excites the terminations of the nerve-fibres in the retina is light. The sensation of light is produced in the brain by impulses reaching certain nerve-centres and coming along the optic nerves. These impulses are, in ordinary circumstances, sent along the optic nerves by the retina, and are communicated to the retina by the vibrations of ether which are held to be the physical cause of light. But any excitement of the optic nerve, if it be passed on to the brain, will produce a sensation of light. Thus electrical stimulation of the optic nerve will do so, because it, equally with the usual stimulus of light, sets up changes in the brain cells, which occasion the sensation. Mechanical stimulation, of which the commonest form is "a blow on the eye," will also excite the nerve and produce sensations of light. It is the terminations of the nerve-fibres —the rods and cones, not the fibres of the nerve themselves, that are excited by light, for light falling directly on the optic nerve alone has no effect, while the feeblest glimmer of light will excite the retina and lead to a luminous impression.

The whole surface of the back of the eye is not, however, equally sensitive. There is, indeed, a spot, where the optic nerve enters the globe, completely insensitive to light. It is, therefore, called the "**blind spot.**" Light falling upon it produces no stimulus. At this point there are no rods and cones, and in this fact is one reason for the belief that the rods and cones are the agents by whose aid the waves of light become transformed into the stimulus of a sensation. A simple experiment proves this. Shut the left eye, and hold the thumb of each hand side by side directly in front of the eye, with a good light falling upon them, and at the distance one would hold a newspaper in reading. Fix the right eye on the nail of the *left* thumb, and then move the *right* slowly away to the side. Though the eye is steadily regarding the left thumb both are seen, when the right is moved only an inch or so, but when the right thumb has been moved off several inches, the end joint disappears from view, though the shut hand is still visible, and when it has been moved a little further the whole right thumb is again visible to the eye, still fixed on the left thumb. The explanation is that at a particular distance the rays of light from the end of the thumb fall on the blind spot, and give rise to no sensation, and when the hand is moved to one side or other of this place the rays fall on the retina on one side or other of the optic nerve entrance and so produce the sensation. If when the thumb has disappeared the hand be moved in any direction, forwards or backwards, the thumb will again come into view, for the rays will be made to fall on the retina. The same thing may be shown in another way. Shut the left eye and fix the right on the small letter a (Fig. 176). Then move the book near to or farther from the eye. In one position the large letter A disappears from view, in others both are visible.

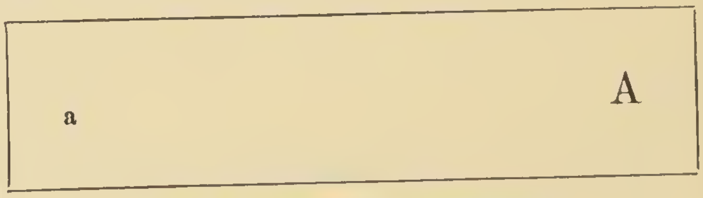

Fig. 176.—To show the "blind spot."

The yellow spot (p. 449). directly in the centre of the back of the eye, is the most sensitive part of the retina to light. Objects are most distinctly seen when the eyes are so directed towards them that light from them falls on the yellow spot. In this spot cones are specially numerous, there are no fibres of the optic nerve, and the other layers of the retina are very thin. This is another reason for the belief that the rods and cones are the true essentials of the terminal organ of vision. In looking at any extended object the eyes are rapidly moved in various directions, so that its various parts are brought in line with the yellow spot. As a result of a fusion of all the different impressions received, which fusion is effected in the brain, the person judges of the appearance of the object as a whole. This grouping of impressions we are often unconscious of. It is done so rapidly and so habitually that we are apt to believe that we see with equal distinctness the whole of an extended object at once. In reading a printed page we know the eye moves so as to perceive one word after another in the printed line, and if we fix the eye on the centre of the line the ends will be indistinct. It is because we move the eyes so rapidly, and because we learn to take notice only of the distinct impressions, due to rays of light falling on the yellow spot, that we are quite unconscious of the existence of a blind spot.

The stimulation of the retina does not pass off immediately the cause ceases to operate. Its effect lasts for a distinct period, about the $\frac{1}{8}$th of a second. If, therefore, two impressions follow one another at a less interval they appear as continuous, since the effect of the one has not passed off before the other is produced. If, in a series of flashes, one follows another at less than the interval named, the impression of a continuous flash will be produced. It is thus that a string, glowing red-hot at one end, and rapidly whirled round, produces the impression of a circle of light. This fact is taken advantage of in the construction of the wheel of life. Here a set of pictures is produced on a circular band of paper, which is set in a revolving wheel. The pictures represent a man, let us say, in the different positions he would be in, one instant after another, during the act of walking, for example. One picture follows another in its proper order, and when the wheel is rapidly revolved the appearance of the man walking is produced.

The Perception of Objects.—Were the retina the complete terminal apparatus of vision all that one could be conscious of would be a sensation of light whenever the retina was stimulated, but we could have no definite knowledge of the object from which the light proceeded. Photographers obtain a picture of a person by the use of a plate of glass on which is a film sensitive to light. This sensitive plate is placed in a box or camera, facing the person. But were the camera a simple box with a hole in front through which the light could fall on the plate behind, the result would be a uniform darkening of the film from the exposure to light and no picture would be produced. What the photographer desires is to throw on the plate an image of the person in light and shade. The parts of the sensitive film on which the light portions of the image fall are strongly acted on, and the parts on which the shadows fall are feebly acted on, and more or less feebly as the shadows are deep or slight. The sensitive plate is thus unequally acted on, and when the photographer has submitted it to the action of certain chemical solutions the film is left thick and dark where the strong light fell, but thinner and more or less transparent in the places corresponding to the shadows. If then he holds his plate up to the light and looks through it, he sees in light and shadow an image of the person who sat before the camera. But to obtain this there must be certain definite parts of the sensitive plate corresponding to certain parts of the person. Thus if the light is shining strongly on one side of the person's face, the sensitive plate must receive the rays reflected from that part of the face, and these rays must not be diffused over the whole plate, but made to fall on a part of the plate corresponding accurately in outline and in proportionate size to the part from which they have proceeded. So it must be with the rest of the figure. On the plate there must be parts corresponding to the parts of the person to be photographed. It is the same in vision. If not merely a general impression of light is to be obtained, but a definite knowledge of things, then on the retina there must be distinct luminous impressions, distinct regions of light and shadow corresponding to the lights and shadows of the object from which rays of light are proceeding to the eye. In short, we cannot see in absolute darkness, we see only when light enters the eye, and we see definite things only when rays of light fall on them and are by them reflected into the eye. If all objects reflected light equally from their whole surface we could not see things defined from one another; and we would have simply a consciousness of a uniformly illuminated surface. Things have definite out-

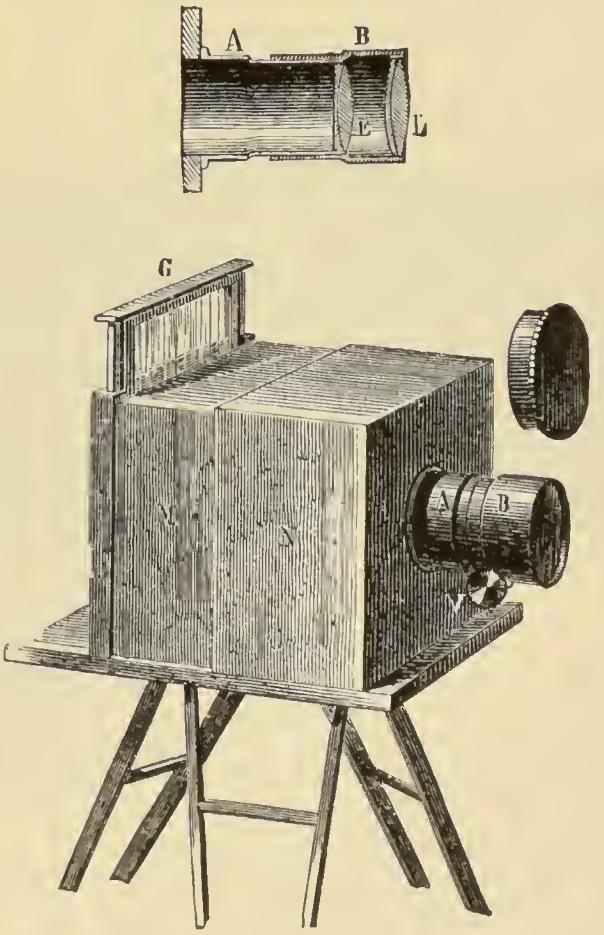

Fig. 177.—Photographer's Camera.

lines, and forms, because light is unequally reflected from different parts of their surface, the illuminated object being mapped out by the shadow that surrounds it. It is only, then, when such illumination and shadow are accurately reproduced on a sensitive photographic plate that an image of a person or object is obtained, and only when accurately reproduced on the sensitive coat of the eye that we can see things distinctly. How then is this accurate reproduction of light and shadow obtained? Let us examine the photographer's apparatus, for in it is an accurate representation of the eye.

The photographic camera is a box (MN, Fig. 177), the inner surface of which is painted a dull black, and which is light-tight. In front is an opening into which is screwed a brass tube (AB) fitted with a series of convex lenses, shown in the upper part of the figure (EL). A screw (V) enables the tube containing the lenses to be worked backwards or forwards in an outer case. The box is closed at the back by a ground-glass plate (G), capable of being removed. No light enters the box except through the opening in front (which may be closed by a cap), and it must pass through the lenses on its way.

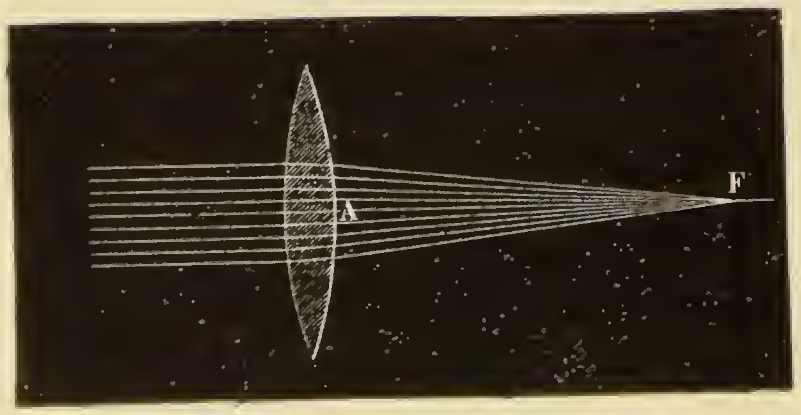

Fig. 178.—Effect of a Convex Lens.

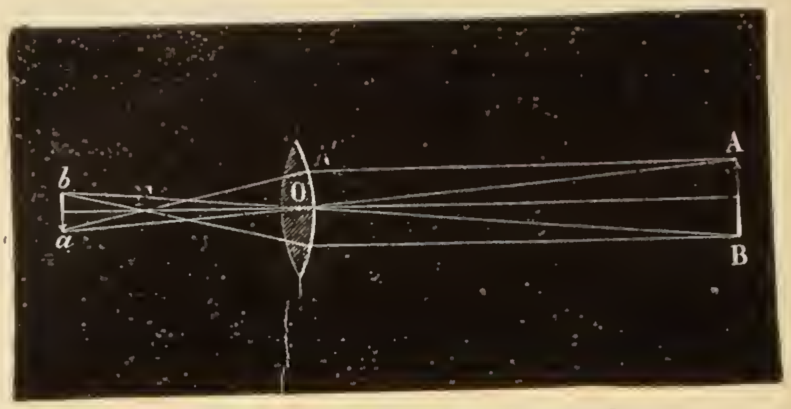

Fig. 179.—Formation of an Image by a Convex Lens.

The effect of a convex lens is exhibited in Fig. 178. It brings rays of light passing through it to a point or focus (F) by refracting or bending them out of their course. Now suppose that the object from which the light is reflected is an arrow, as in Fig. 179. The rays of light from the point of the arrow (A) are acted on by the lens and brought to a focus at *a*, the rays from the other end of the arrow are focussed by the lens at *b*, and rays from every other point of the candle are focussed at corresponding points between *a* and *b*, so that rays from every point of AB have corresponding points in the line *ab*. In short, an image of AB is produced at *ab* through the agency of the convex lens, but the image is upside down, because, as we see, *a* is the image of A, and *b* of B. Now if at *a b* a screen were placed, and if all light except that passing through the lens were prevented falling on the screen, a bright distinct image of the arrow would be seen, but smaller than the real object and upside down. The conditions would be accurately fulfilled if the screen were on the back wall of a black box which had an opening in front in which was fixed the lens. But this is just a camera with its ground-glass plate as screen. The inside of the box is blackened to prevent reflection of light which would mar the distinctness of the image. Now from Fig. 179 it will be evident that if AB were brought nearer to the lens, its image *a b* would not be found in the same place. It would be further removed. The screen would require to be moved back a bit. Suppose the screen were immovable, the lens might be altered in position so as to bring the focus once more on to the screen. If the lens could not be moved, nor the screen, the new position of AB would cause its image to fall behind the screen. If another lens were placed in front or behind the original one its action would be strengthened, the rays would be brought to a focus sooner, and if the added lens had the proper degree of convexity (of thickness in the middle) the image would be brought forward so as to make it once more fall on the screen. Now in a photographer's camera the screw which moves the lenses backwards or forwards in their outer tube is for the purpose of bringing the focus always on the ground-glass plate Usually also the box is made so that it can be lengthened or shortened to effect the same purpose, for the lenses always remain the same. Another thing remains to be noticed about the photographer's camera. Lenses focus more quickly rays of light passing through them near the circumference than those passing through the centre. Both sets of rays are not focussed at the same point. If the rays come from an object, the image produced is not definite, because all the rays of light are not equally focussed. Now in a camera this is corrected by the use of a stop or diaphragm. It consists of a plate of metal with a hole in the centre. This is passed through a slit in the metal tube between the lenses. It cuts off the outside rays, the centre ones only passing. The holes are made of various sizes to suit the amount of light. By means of the stop an element of confusion is removed and the image made very distinct.

Now if this description of a photographer's camera be applied to Fig. 174 it will be evident how accurately it represents the purposes of the eyeball. The eyeball is a chamber with compact walls into which light can pass only through a clear portion in front (the cornea). Like the camera the eyeball has a dark coat to prevent reflection of light, the dark choroid. Towards the front is a lens—the crystalline lens—through which all rays of light that enter the eye must pass. The lens focusses the rays as any ordinary lens would do. But the action of the lens is aided. There are several refractive substances forming the eye. The cornea refracts slightly, so also does the aqueous humour filling the anterior chamber, and the vitreous humour filling the posterior chamber does so to a greater extent than either cornea or aqueous humour. Thus the moment rays of light enter the eye they begin to be bent out of their course, and the result of the action of the lens, aided by the cornea and aqueous and vitreous humours, is that rays of light that are parallel when they fall upon the eye are brought to a focus on the back wall. If then an object is a long distance off, rays of light proceeding from it and falling on the eye are brought to a focus on the back wall of the eye, and there will be produced a small image of the object *upside down* (Fig. 180). Suppose the object is brought near, then, as we have seen with a lens, the image would fall beyond the wall of the eyeball. To secure that it fall on the wall exactly, one of three things is necessary, as we have seen, the wall must be moved further back, or the lens must be capable of movement, or there must be some way of increasing the focussing power of the lens, so that the rays are sooner brought to a focus, and thus made, once more, to fall on the wall. In the eye it is the convexity of the lens that is altered, and by this means the eye is capable of accommodating itself to different distances, as it is phrased.

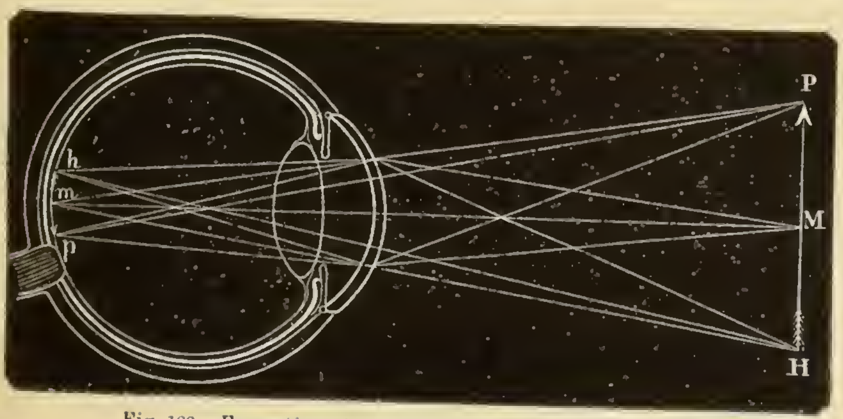

Fig. 180.—Formation of Image on the back of the Eyeball.

Rays of light proceed from the points P, M, H of the arrow and are focussed by the lens and humours of the eye to form an image, p, m, h, which is smaller than the object and inverted.

Accommodation of the Eye to different distances. We are continually moving our eyes from object to object, now looking at something at a distance, now at something near, and again at something far off. To see each thing distinctly the eye must be capable of altering itself with great precision and rapidity to suit the varying distances. The lens is a very elastic body, as stated on p. 448, and is confined within a capsule which presses upon it, and flattens it somewhat. But the pressure of the capsule may be relaxed by contraction of the ciliary muscle (p. 448), so that the lens bulges forwards and becomes more convex. When we look at a near object the ciliary muscle contracts, the capsule relaxes, the lens bulges forwards, the rays of light are thereby more refracted and the image of the object is distinctly produced on the back of the eyeball. When the object is nearer, the ciliary muscle contracts more, and the lens becomes still more convex. When the object is far away, if the lens were to remain as before, the image would be formed in front of the back of the eyeball, and, therefore, the ciliary muscle relaxes, the capsule tightens, the lens is flattened slightly, refracts less strongly, and the image is formed on the back wall as before.

Normal or regular **Sight** exists when the degree of convexity of the lens and the length of the eye are such that rays of light coming from a distance are brought to a focus on the retina—the lining of the back of the eye—*without any effort of the eye*, the eye remaining at rest. Practically all objects at a distance of about 70 yards and upwards from the eye require no effort of accommodation. This distance from the eye is the far point at which the need of accommodation ceases, and it has been called the *punctum remotum*, or far point. As soon as an object comes nearer than that, the lens must begin to become more convex, and the nearer the object comes the more does the lens increase in convexity by the contraction of the ciliary muscle, till the object is so near that every effort is made to produce greater contraction and thereby greater convexity, and a sense of straining is experienced. A point is at last reached so near to the eye that no further accommodation can be effected, and, if the object is brought nearer, it is no longer distinctly seen. This point is the *punctum proximum* or *near point*, and for the ordinary eye the distance is about six inches. In other words, from an object, distant 75 yards and upwards from the eye, reflected rays of light falling upon the eye, and passing through its lens, humours, &c., come naturally to a focus on the retina and form an image there, without any effort of the eye. Rays from an object any nearer than that would be focussed behind the eye were no effort made, but by the arrangements for accommodation the lens becomes more convex and the rays are focussed sooner, so that they again fall on the retina. As the body comes nearer and nearer the effort on the part of the eye to focus the rays becomes greater and greater till no greater effort can be put forth, and if the body be nearer than six inches the effort is not sufficient, the lens cannot become convex enough, and thus the rays are no longer brought to a focus on the retina, and in consequence the body can no longer be distinctly seen.

Long-sight (*Hypermetropia*).—If the arrangements necessary to secure distinct vision when a person looks at objects at varying distances from the eye be understood, the defects of the eye, termed long-sight and short-sight, will be readily comprehended. We have seen that in ordinary conditions of the eye, rays of light from distant objects form a picture on the retina without any effort on the part of the eye. Now suppose the distance between the back wall of the eye and the front is less than usual, other things being usual, rays of light from far-off bodies will reach their focus not on the retina, as they ought to, but behind it, because the retina is not so far back as it ought to be. (Refer to Fig. 181.) If the difference from the normal be slight, the person is able to correct it by a slight effort of accommodation. By this slight effort the lens becomes more convex, brings the rays sooner to a focus, and thus brings the picture forwards so as to make it fall on the retina, when the object is distinctly seen. The effort required may be so slight that for a long time the person is unaware of it. But the meaning of the condition is, that even when the person is looking at far-distant things, which in ordinary circumstances he should see distinctly without any movement of the lens, even when looking at these far-off things his eyes are not at rest, but require to focus to make the image fall on the retina. As the object comes nearer the amount of focussing required becomes greater, and the power of accommodating the eye to see distant objects, having begun sooner than is usual, is sooner exhausted. That is, the eye becomes unable to focus any further before the object has come so near the eye as is usual. Thus a person with long-sight is unable to read a letter or newspaper, let us say, when it is held the ordinary distance from the eye, because his focussing power has failed sooner than is customary. He, therefore, holds the paper or letter farther off from his eye than ordinarily is done. The "near point" is farther away from the eye than in ordinary sight. The defect is called "long-sight" on this account. The remedy is evident. Suppose it is at twelve inches from the eye that the power of the lens to become more convex fails, by placing in front of the eye a spectacle whose surface is convex—rounded—the lens is aided, the focus of the rays is brought forward, and the person can now hold his letter or paper nearer and yet see distinctly. (Refer to Section XXIII.)

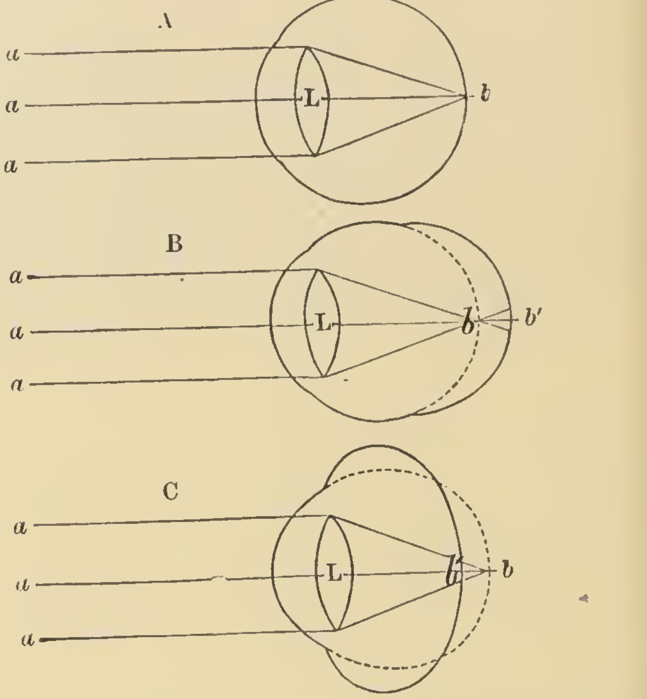

Fig. 181.—A, Ordinary Eye, rays of light *aa* from a distance coming through the lens L to a point *b* on the retina. B, Short-sighted Eye, rays from a distance coming to a point *b* *in front* of the retina *b'*. C, Long-sighted Eye, rays from a distance coming to a point *b* *behind* the retina *b'*. L is the lens in each case.

The accommodation of the eyes of a long-sighted person is never at rest. The result is that in time a feeling of strain and soreness is produced, and the eyes become red and watery, especially when the person reads, writes, sews, or performs any fine work, since, the nearer the object is, the more effort is required to see it distinctly.

Short-sight (*Myopia*) is the opposite condition to the former. The distance between the back and front of the eye is greater than usual. When the person looks at distant objects, the focus does not fall on the retina as in ordinary sight, nor yet behind the retina as in long-sight, where the distance is less than usual, but it falls in front of the retina. (Fig. 181, c.) It is plain that the person can do nothing to correct this. His eyes are at rest, and yet the focus is in front of the retina. Any effort of accommodation would make things worse, by making the lens more convex, and bringing the image still farther forwards. If the lens could be flattened so that the rays were not brought to a focus so soon, distinct vision would result, but there are no arrangements for doing this. The eyes are at rest, and in this state the lens has its least degree of forward curve. Now as the object looked at comes nearer and nearer the focus gradually passes back till at length it falls on the retina, and the person then sees the object distinctly. Thus a short-sighted person cannot see persons or things distinctly at a distance. Moreover, a short-sighted person sees distinctly, and without any accommodation by his eyes, that is, his eyes being at rest, an object at the distance for which a person with ordinary sight requires to focus strongly. That is to say, the short-sighted person does not require to bring into play the arrangements for accommodation so soon as the person with ordinary sight, and thus the accommodation of the person with ordinary sight is exhausted before that of the short-sighted person. Thus, when the ordinary individual has brought printed matter so near his eyes that if he holds it any nearer it is no longer distinct, the short-sighted person can bring it much nearer and still see it distinctly. Indeed to see it distinctly he requires to hold it nearer than the ordinary reading distance. On this account the defect is called "short-sight." It is thus evident that the short-sighted person cannot by any means see things at a distance distinctly, because the picture does not fall on the back wall of the eyeball; on the other hand he sees things very much nearer than usual. To correct this some arrangement is required which will prevent the rays of light coming so soon to a focus, by which means the image will be produced further back and made to fall on the retina. A concave spectacle—one hollow on the surface—does this, for it slightly disperses the rays, and they are brought to a point later than they would otherwise be. (Refer to Section XXIII.)

The Movements of the Eyeball.—The eyeball is controlled by a set of six small muscles, which, with one exception, are attached to the back part of the cavity in which the eye rests. The muscles pass forwards and are connected by thin flat tendons to the outer coat of the ball, a short distance behind the clear part of the eye—the cornea. Four of these muscles run a straight course, and are called **recti muscles** (Latin *rectus*, straight). One is attached in the middle line above, another below, and one to each side of the eyeball. They are, therefore, called superior, inferior, internal and external. Acting alone one would turn the eye upwards, another downwards, the third inwards, the last outwards. The other two muscles bend in their course, and are called **oblique muscles**. One arises behind in common with the four straight muscles, and passes to the front towards the inner angle of the socket, there it ends in a round tendon and passes over a tendinous pulley. From the pulley it changes its course, proceeds over the eyeball slightly backwards and becomes attached to the ball at its outer side. When it contracts, acting round the pulley, it rolls the ball. Since it proceeds over the eye it is called the **superior oblique muscle**. The other oblique muscle is below—**inferior oblique**. It springs from the lower part of the inner angle of the socket and passes below the ball towards its outer side where it is attached. When it contracts it also rolls the eyeball, but in an opposite direction to the superior oblique. These oblique muscles do not act alone, but in association with one or other of the straight muscles. In combination they produce the varied movements which the eyeball can so freely perform.

As a rule both eyes are moved at the same time in the same direction, so as to regard the same object. When one muscle becomes paralysed so that the eyeball cannot be turned in that direction, the two eyes no longer act together, when the person seeks to look that way. The sound eye is turned far enough, the other fails to go round. Squinting is produced, and the particular object looked at is seen double. As soon as the eyes are turned in other directions, they again act together, the squint disappears and the vision is single. (Refer to **Double Vision**, p. 458.)

The Information gained by the Eyes.—It may be well to state here briefly the substance of the foregoing paragraphs. The eye is to be regarded as the peculiar form of ending of the optic nerve, designed to be affected only by light, and so excited by light as to send on to the brain an impression which there gives rise to a sensation of light. It is supplied with a series of structures that act as convex lenses, which so focus rays of light, passing through them from external objects, as to form small images of these objects on the retina, the nervous coat that lines the inner surface of the back chamber of the eyeball. Now the first thing to notice is, that it is this image on the retina that produces the sensation of seeing something, and yet we are not conscious of the image on the retina but only of the outward thing from which the rays of light proceed. This is difficult to understand. It is doubtless the result of education. We learn that the things we see are the result of impressions reaching us from the outside, and we refer the object from which the impressions reach us outwards in the direction of the straight lines in which the rays of light fall upon the eye. Thus, it is related of a patient, who was blind from his birth owing to cataract, that when sight was restored by an operation, performed by the English surgeon Cheselden, he thought all objects he saw touched his eyes. His other senses corrected his mistake. He found when he put his hand up that the objects did not touch his eyes, that he had to walk towards them in order to touch them, &c. Thus he trained his eyes by means of other senses, and in other ways, to appreciate the distance from him of the objects he saw. Again, the brain of the man suffering from delirium tremens is disturbed and excited by what he has drunk. The seeing centre in the brain is aroused by the stimulant and perverted by it, and he becomes conscious of images so produced, and believes them to represent actual existences. The creatures that leer at him, and crawl over him, and dance before him, are the creations of his excited brain, but his judgment is also perverted, and he is unable to perceive that they have no real objects corresponding to them in the external world. Again, when pressure is exerted on the eyeball, or when a sudden blow is received on the eyes, the nervous apparatus of vision is excited and colours or bright sparks (called **phosphenes**) are seen, which only experience teaches to be due to internal disturbances. The production of what are called **Purkinge's figures** is another example of the same thing. If a person goes into a dark room with a lighted candle, and, facing a blank plain-coloured wall, holds the candle to the side of the head, moving it up and down, the appearance of branching lines will be seen on the wall. These are shadows of the blood-vessels of the retina (p. 449), The sensitive portion of the retina (the layer of rods and cones) is behind the blood-vessel layer, and thus the lines of vessels intercept the light passing in at the extreme side of the eye, the shadows produced appearing to the person to be something outside. Then it is well known that minute floating bodies in the humours of the eye produce shadows which to the person seem to float across his vision in space. These are called **muscæ volitantes**. It is then only by a process of education, in which the various senses take part, that a person learns to judge of the actual existence of an outward object corresponding to his sensation. It may be remarked that a similar explanation applies to **hallucinations**. This is the term given to things a person seems to see for which there is nothing externally to account. There are undoubted cases on record where an individual has seen a person or thing in the immediate neighbourhood, and by going up to the place has assured himself that nothing but simply space existed there. Sir David Brewster gives a case, in his *Natural Magic*, of a lady who on entering the drawing-room saw her husband standing on the hearth-rug with his back to the fire. She addressed him and sat down in a chair within two feet of the figure. After she had again spoken, the figure moved off to the window and then disappeared. Frequently afterwards she had similar experiences, seeing other persons and things, in the presence, on one occasion, of her husband, who assured her that the cat she saw sitting on the rug at his feet had no actual existence. She herself had the courage more than once to convince herself that the appearance was a deception by sitting down on the chair on which she saw someone sitting, when the appearances vanished. In these cases changes were excited in the nervous apparatus of vision not due to any outward existence, though as a rule only produced by such, and the lady was consequently for the time deceived, until she had corrected her sensations by other means.

Another thing to be noticed is that the image on the retina is upside down, and yet we see things in their upright position. When we direct our eyes towards a particular object rays of light pass into the eye not only from that object but from other parts in its immediate surrounding, and we become conscious not only of the particular object we are looking at but of a region round about it. This region is called the **visual field or field of vision.** Now rays of light coming from the left of the field of vision fall on the right side of the retina, rays from the upper part of the field fall on the lower part of the retina, rays from the lower part of the field on the upper part of the retina, and so on. We refer the image on the lower part of the retina in the direction from which the rays come, that is, towards the upper part of the field of vision. Moreover we interpret by means of touch, for, to reach with the hand the part of the object whose image is on the lower part of the retina, we must raise the hand, and to touch the part of the object whose image falls on the right side of the retina we must pass the hand to the left side, and so on. Thus though the image is upside down on the retina, we see the object upright.

The **estimate of size** given by the eyes depends on the angle formed by the rays of light before crossing in the eye. This is explained by Fig. 182. From the object PAH, rays P*p*, H*h* pass to the eye. At O they form an angle POH. This is the visual angle, the angle under which PAH is seen. PAH forms an image *ph* on the retina, and its apparent size is dependent upon the angle at O. But the lines P'BH' and P''CH'' are seen under the same visual angle, and will, therefore, have the same apparent size, and form images of the same size on the retina. To this impression, however, there remains to be added the idea of distance. We know that as objects pass farther and farther away from us they appear smaller and smaller, and as they approach they become larger. If, therefore, an object at a great distance off appears as large as an object very near to us, we judge the far-off object to be much more extensive than the near one.

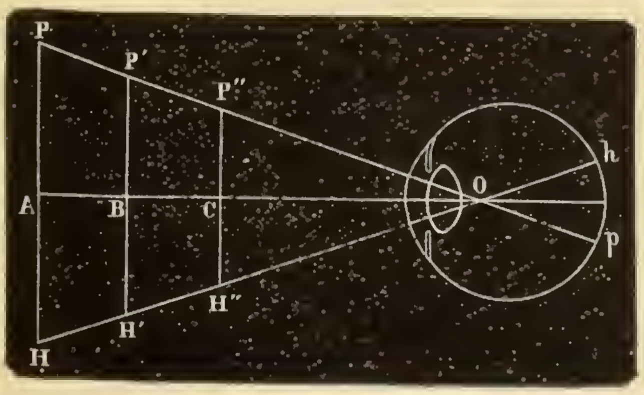

Fig. 182.—The Visual Angle.

Our **appreciation of distance** is guided to a large extent by the clearness with which the object looked at is perceived and its details made out. If the atmosphere be very clear, mountains at a distance appear nearer than they do when the atmosphere is hazy. An artist gives an impression of distance to the objects in the background of his picture by the want of distinctness of their outline and detail. It is very difficult, however, to judge absolutely of distance. Between us and a distant object a great many other objects intervene, whose distance from us we can more readily estimate. We thus guide ourselves in forming an idea of the distance of the far-off object by the others which are between, and which afford us something to measure by. Thus everyone knows the errors easily made by sailors at sea in judging of the distance between their ship and another, because of the absence of anything between to aid the vision.

For various reasons, therefore, judgments formed by vision of the real size and distance of things are not too reliable. A good illustration is given in Fig. 183. The distance between A and B seems greater than the distance between B and C, and yet it is the same, the apparent increased space between A and B being due to the markings between. For the same reason, of two squares absolutely identical in size, one marked with alternately clear and dark cross-bands, and the other with alternately clear and dark upright markings, the former will appear broader and the latter higher than the other. Thus a short stout person whose dress is cross-striped or made with flounces appears stouter than she really is, and a tall woman whose dress has upright markings or folds that run up and down exaggerates her length. Consequently a stout person who wants to increase her apparent height and diminish her apparent stoutness should wear dresses striped or folded up and down, and a tall person who wishes to diminish her apparent tallness and to appear stouter should wear cross-marked or folded dresses.

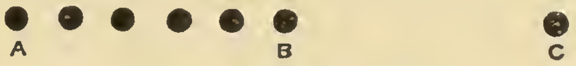

Fig. 183.—Judgment of Distance.

Single Vision with Two Eyes. When we look at an object with both eyes, it appears under ordinary circumstances as a single object. Two images of the object are produced, however, one on the sensitive coat (retina) of each eye, though we are not conscious of two images. If now a finger be pressed strongly on one eyeball so as slightly to push it to one side, the object will appear double; when the pressure is removed the object is again single. It seems, therefore, that single vision with two eyes is produced when the image of an object falls on the corresponding part of each retina. If one eye be so displaced that the image falls on a part of its retina that does not correspond to that of the other eye, then the object appears double—**double vision**, as it is called, is produced. In looking from one object to another the eyes are moved together in harmony with one another, and single vision is constantly secured. If, however, a person suffers from paralysis of one of the muscles of one eyeball, then it is evident that when the eyeballs are moved in a particular direction the paralysed muscle will be unable to contract, will be unable to pull the eyeball round in that special direction, and thus, while the eyeball, whose muscles are all sound, is properly directed to the object, the other one cannot be sufficiently brought round, the image of the object will not fall on corresponding points of the two eyeballs, and double vision will result. Since only one muscle is affected, the eyeball can be moved quite freely in every direction but one, and thus in all other directions single vision will be produced, because in all directions but one both eyeballs will act together. Persons who squint would also "see double" were it not that they accustom themselves to use only the straight eye, and speedily become altogether unconscious of the image on the squinting eye.

Single vision with two eyes, that is **binocular vision**, enables us to judge of the solidity of objects looked at. The image that falls on each eye is not absolutely the same, because each eye regards the object from a very slightly different point of view. The two images, differing so little from one another, are fused together in our consciousness; but the result of the slight difference is to give us a particular impression which experience has taught us is due to the object being not flat but raised—we have, that is, the impression of a solid body. This may be illustrated by a very simple experiment. Fig. 184 shows two views of a cube; the view on the right hand presents the appearance that would be perceived suppose a cube were looked at by the right eye, while on the left hand is the appearance of the cube to the left eye, the position of the person not being changed. Now let one take a card about 10 inches long and hold it between the two views, let the person rest his forehead on the upper end of the card and look on the figure, so that the left eye sees only the left view and the right eye sees only the right view; with a slight converging of the eyes only one cube is seen, but it is neither the right-hand nor left-hand view, but a view produced by an overlapping of the two, and the cube stands out from the paper as if it were actually a solid body.

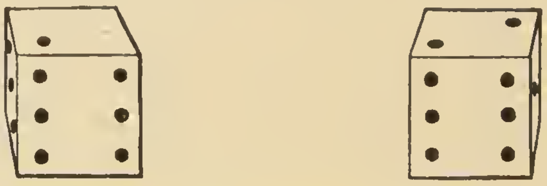

Fig. 184.—Stereoscopic Views.

This is the principle of the **stereoscope**, Fig. 185. It is a box divided into two sides by a thin partition down the centre. In the bottom of the box is placed a card on which are pasted two photographs of the same thing. Each photograph, however, has been taken from a slightly different point of view, so slightly different that, without careful examination, one would conclude they were both absolutely the same photographs. The views are of such a size that each one extends across the space in the bottom of its compartment, and the central partition accurately separates the two. At the opposite end of the box are two lenses, so placed that when the box is held up to the eyes each eye looks through one lens. Looking through the glasses each eye sees a photograph, slightly magnified. The lenses are of such a shape that they cause a slight displacement of the pictures, so that the images fall on corresponding points of the two eyes. The two images are fused together, and one becomes con-

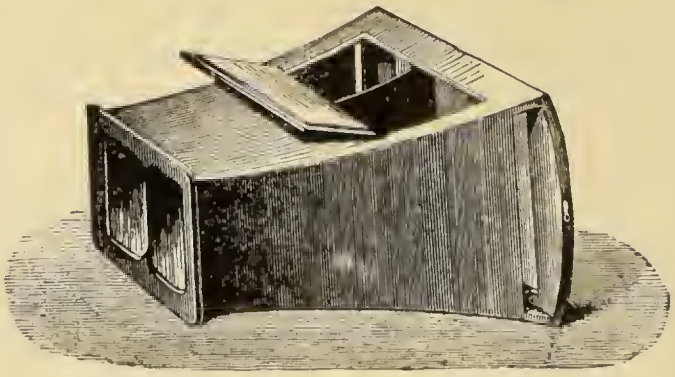

Fig. 185.—The Stereoscope.

scious of only one picture, in which the objects stand out in relief, just as they would appear were one looking at the actual objects themselves.

Colour. Ordinary sunlight appears to be compounded of seven different colours: red, orange, yellow, green, blue, indigo, and violet. If a wedge-shaped piece of crystal—a prism—be held up between the sunlight and the eye, these various colours will be seen, because the prism separates the white light into its constituent colours. The band of the different colours produced in this way is called a spectrum—the spectrum of sunlight. The rainbow is such a spectrum. The same thing can be shown in another way. If the seven colours be painted on a wheel as indicated on Fig. 186, and in proper proportion, and the wheel be turned on a pivot through its centre with great rapidity, the eye will not perceive any colour at all, but the wheel will appear a dull white. If, however, one of the seven colours be omitted, the revolving wheel will be no longer white. The six remaining colours will still be fused together, so as to give the impression of one colour—the result of the union of the six.

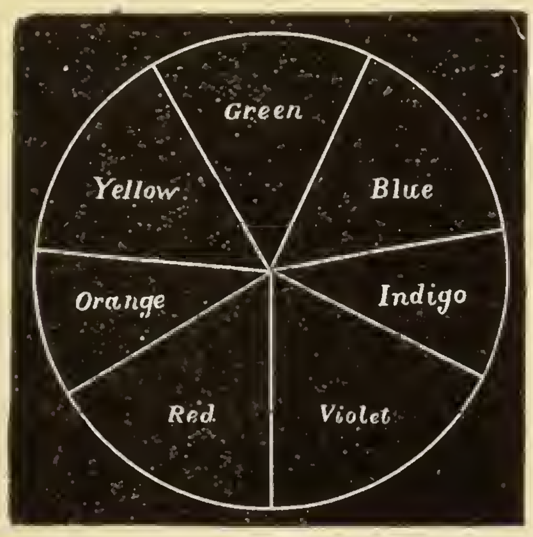

Fig 186.—Rotating Disc of Sir Isaac Newton for mixing Colours.

Now bodies appear variously coloured because of their behaviour to white light. Some bodies held up between the light and the eye permit all the rays to pass through, and therefore appear without colour, other bodies do not permit all the rays to pass, they intercept some. Thus one body keeps back all rays but the red; they alone pass through, and thus the object appears red. Another body keeps back all the rays but the yellow and some of the red, and it appears to be orange. A third body permits only the violet rays of white light to pass, and it, therefore, appears violet, and so on. Again another class of bodies do not permit rays to pass through them, but they reflect rays. Their apparent colour depends upon whether they reflect white light unchanged, or whether they reflect only some of the seven different rays of white light and retain or absorb others. A body that reflects the white light unchanged appears white, a body that does not reflect it at all, but absorbs it, appears black. One body absorbs all rays of white light except red, these it reflects and it appears red in consequence. If you throw a beam of red light on such a body, say a piece of red ribbon, it reflects the rays and appears brilliantly red. But throw a ray of yellow light on the red ribbon, it does not reflect but absorbs yellow light; in consequence it appears no longer bright coloured, but almost black. An orange ribbon reflects partly red and partly yellow rays of white light, the others it retains, and it therefore appears orange, that is a blend of red and yellow.

It has been said that the seven different colours of the spectrum, painted in certain proportions on a wheel which is turned with great rapidity, will produce the impression of white. It has been found that these seven separate colours are not required, but that the impression of white can be produced by three colours only, viz.:—

Red.
Green.
Violet.

These three painted in proper proportion on a wheel will give the impression of white. Moreover, all the seven colours of the rainbow can be produced by varying the proportion of these three colours. On this account they are called the **fundamental colours**.

Complementary Colours are not to be confounded with the fundamental. There are certain pairs of colours which when blended produce a sensation of white. Thus:—

Red	and Blue-Green	produce	White.
Orange	,, Blue	,,	,,
Yellow	,, Indigo-Blue	,,	,,
Green-Yellow	,, Violet	,,	,,
Green	,, Purple	,,	,,

That is to say, given red, the other colour required to produced white is bluish-green; or given bluish-green, the other colour required is red, and so on. These colours are therefore said to be "complementary" to each other, because they together produce white.

Here a mistake must be guarded against. It must not be supposed that it is meant that a mixture of paints of these colours will produce a white paint. A red powder and a bluish-green powder will not produce a white one, as everyone knows, nor the mixture of red and bluish-green liquids. But if, at the same instant, the eye be affected by red and bluish-green light, the sensation is not of either colour, but of white. It is the sensation that must be mixed, so to speak, and the mixed sensation is not produced by a mixture of the differently-coloured powders or liquids.

The Perception of Colour by the eye is explained by a theory first proposed by Thomas Young, and afterwards more fully worked out by the German professor, Helmholtz. According to that theory there are in the eye three sets of nerve-fibres capable of being excited by the fundamental colours (see above). One set is excited by red light, another by green, and another by violet. Just as the different colours of the rainbow may be produced by various proportions of these three colours, so may different sensations of colour be produced by the excitement of these three sets of nerve-fibres in different amounts. Thus, when all the three sets of fibres are nearly equally excited there is a sensation of white. Red light will strongly arouse the nerve-fibres sensitive to red, and will barely affect the other two. Yellow light will moderately excite the fibres sensitive to red and green, and not those sensitive to yellow, and the result is not a sensation of red or green, but of yellow. Blue light excites moderately the fibres sensitive to green and violet, and barely affects those sensitive to red, and there is a sensation of blue. This theory would account for colour-blindness. Thus, if the fibres that ought to be sensitive to red for some reason or other did not respond at all, the person would be unable to perceive red. (Colour-blindness is considered at length in the second part of this section.)

After-images are also explained by the theory of colour and its relation to the perception of colour. If, on awaking in the morning, we look *for an instant* towards a window through which bright sunlight is streaming, and then turn away the head and shut the eyes, we are aware of an image of the window, in which the panes appear white and the sashes, &c., dark, as they appeared when actually looking at them. This is a **positive after-image**, and is due to the fact that, the sensitive coat of the eye being highly excitable by the long rest of the night, the effect of the stimulus of the light lasts even after the exciting cause has ceased to operate. If, however, we gaze *for a time* at the window and then look away and shut the eyes, or look towards a dark part of the room, we see an image in which the light and dark parts are reversed, the panes being dark and the sashes white. This is a **negative after-image.** It is due to the sensitive coat of the eye being fatigued in certain parts. The parts corresponding to the panes, on which the strong light fell, are exhausted and appear dark, while the parts corresponding to the sashes, on which the light did not fall, are still unexhausted and therefore appear light. In a short time the retina recovers and the experiment may be repeated.

Now, suppose we look fixedly for a short time at a white sheet of paper on which is a red spot, a bright light falling on the paper, and then turn the eyes to a plain white sheet of paper or to a white wall, an image of the spot will appear to float before the eyes, but it will not be a red image but bluish-green. The explanation of this is similar to that of after-images. The sensitive coat of the eye has been exhausted, but not to all the constituents of white light, only to the red. The result is that an after-image floats before the eyes, whose colour is that of white light less the red, in other words, the colour which with red goes to make up the sensation of white, the complementary colour of red, namely bluish-green. Similarly if the spot gazed at has been bluish-green, the after-image will be red. If the spot be orange the after-image will be blue, &c. The experiment may also be varied. Thus a large red spot may have a name written across it in another colour, in which case the after-image would show a bluish-green ground and the name would be in a different complementary colour.

HEARING.

THE NATURE OF SOUND.

Sound is a form of movement. This may be shown in various ways. We all know that a tightened string may be caused to give out a musical sound by being pulled strongly to one side and then let go. The string makes a rapid to-and-fro motion, which is accompanied by the sound. As the motion becomes less vigorous the sound becomes feebler, and when the movement stops, the sound also ceases. The limbs of a tuning-fork are in rapid motion when it is sounded. In the case of very large heavy forks the to-and-fro movement can be seen; but in the case of small forks, such as those used by musicians, the motion is so fine and rapid that it is not visible. When a bell sounds, after being struck, it can be shown to be in motion; not moving as a whole, but the particles of which its mass consists being in rapid vibration. Now suppose we have a small bell the hammer of which is worked by clockwork; let us place it on the plate of an air-pump, resting on a thick cushion of felt; and let it be covered with the glass bell-jar of the air-pump. If the clockwork be working we still hear the sound through the glass. Now let the pump be worked so as to remove the air from the chamber, and as soon as a considerable quantity of air has been removed the sound becomes very feeble. When the glass jar has been as completely exhausted of air as possible the sound is no longer heard, though the hammer may still be seen to strike the bell. The stroke still causes vibrations of the particles forming the substance of the bell, but owing to the absence of air there are no means of communicating the vibrations to the ear of anyone in the neighbourhood. This shows, then, that sound is a movement, that it is only when the movement is conveyed to the ear and affects the nerves of hearing that the sensation of sound is produced, and that it is usually the atmospheric air that acts in conveying the motion to the ears.

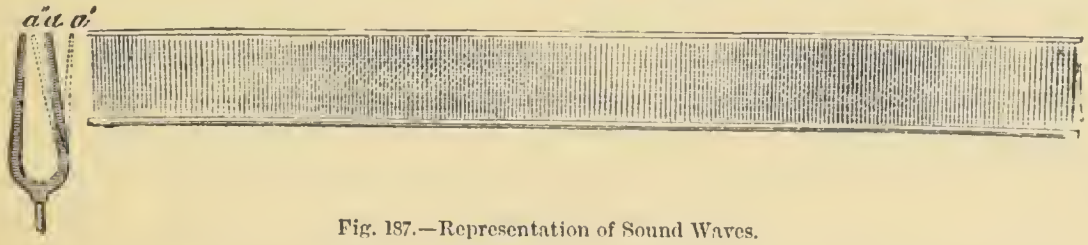

Fig. 187.—Representation of Sound Waves.

The sound movements, or vibrations as it is better to call them, are conveyed through the air in a wave-like fashion, represented in Fig. 187. The figure shows a tuning-fork, supposed to be sounding. Its limbs are, therefore, in a state of rapid vibration. In the figure what occurs is shown only on one side. The limb a moves to and fro, now in the position a', and now in the position a''. When the limb moves from a to a' the air in contact with it receives a shock, and the particles of the air are crowded together by the blow. When the limb moves from a' to a'' the particles that were crowded together have now more space at their disposal, and are less crowded than before the shock of the limb. But with great speed the limb moves back from a'' to a', and again the particles are crowded, and then it rapidly returns to a'', where the greater space is again created. Thus, while the fork continues to vibrate, the particles of air in its immediate neighbourhood are at one moment crowded together, at another moment the opposite is the case, and this goes on on each side of the fork as long as its movements continue. The crowding together of the particles of air by the shock of the fork is called a *condensation*, and the opposite movement a *rarefaction*. To use these terms, then, the air on each side of the limb of the fork is at one moment in a state of condensation and at another moment in a state of rarefaction, in time with the vibrations of the fork. But this peculiar agitation is not confined to the air that is in immediate contact with the fork. The condensation travels outwards from the fork through the atmosphere, and the rarefaction likewise; and as long as the fork keeps going these two conditions are passed along through the atmosphere from the sounding body, which thus becomes a centre of disturbance, just as a stone thrown into still water imparts a shock to the water, and from the place where it struck waves pass outward on all sides. Fig. 187 represents by the difference in the shading the alternate condensation and rarefaction. Now we all know that a person in a boat on the water will become aware of the agitation of the water, even though at a distance from the centre of disturbance, by the waves rippling up to him. Even so a person becomes conscious of a disturbance in the atmosphere, though he be at a distance from the place where it is produced, because the waves of condensation and rarefaction, spreading outwards on all sides from the vibrating body, at length reach him and beat upon him. They affect his ears, they irritate his nerves of hearing, and so he becomes aware of what he calls sound. If we could see air, as we see water, we would perceive the disturbance, caused by a sounding body, passing through it.

It takes a certain time for sound to travel. The rate is about 1090 feet per second when the temperature of the air is 0° Centigrade, and is increased when the temperature is raised. Everyone who has watched the discharge of artillery from a distance knows that the flash and smoke from the gun's mouth are perceived a brief time before the report is heard. If the interval between the two be taken, remembering the rate at which sound travels, one may readily make a rough estimate of the distance of the gun—allowance, of course, being made for wind. Now if the atmosphere were visible, with the gun's discharge a tremendous disturbance would have been seen to take place in the air at the gun's mouth at the moment the flash was seen. This disturbance would be seen spreading outward in all directions, and travelling with great rapidity. Suppose the person stood watching the advancing agitation, then, just at the moment when it reached and enveloped him, he would hear the report. So that when a person walks through a crowded and noisy thoroughfare his ear is being assailed by numberless waves of sound of all kinds and sizes and degrees of rapidity, that surge and swell in the atmosphere around him.

There are various characters of sounds which it is necessary to have some idea of for the proper understanding of the apparatus of hearing. These characters are best exemplified by musical sounds, which are distinguished from ordinary sounds by the regular rhythmical character of their wave movements.

Musical Sounds differ in loudness or intensity, in pitch, and in kind or quality.

The loudness of sounds depends on the extent of the vibration or movement—the largeness of the wave, so to speak.

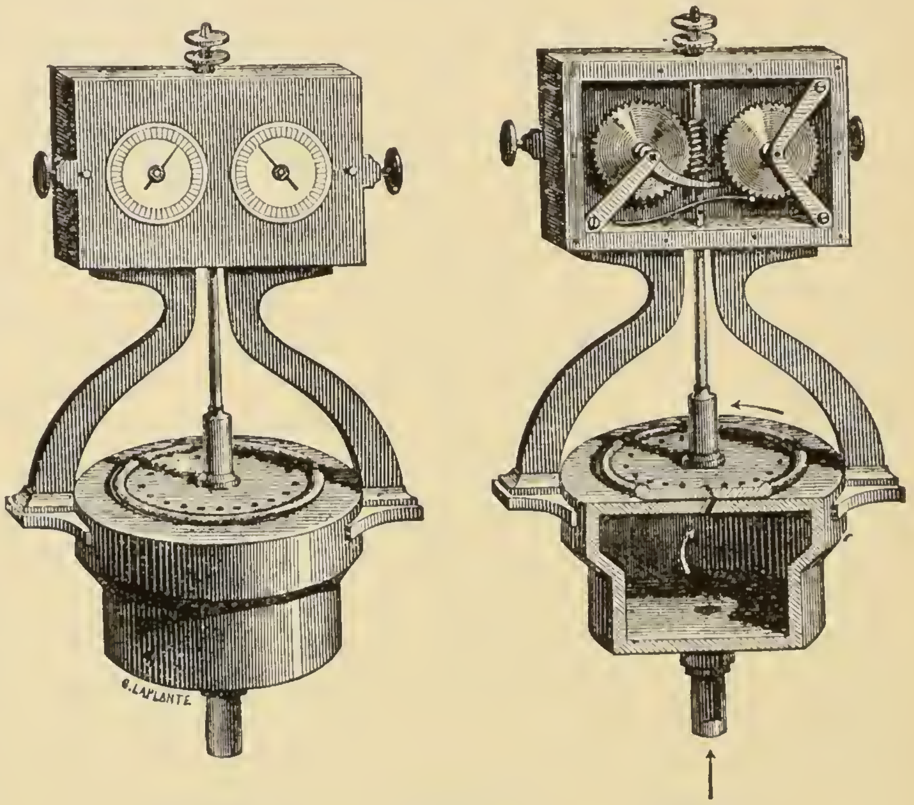

Fig. 188. The Siren. Fig. 189.

The pitch of the sound is determined by the number of vibrations that take place in a second of time. Thus a tuning-fork whose limbs move to and fro 100 times a second will give out a sound of a certain pitch, and a tuning-fork that executes 200 movements in the same time will sound a note of a higher pitch—will, in fact, sound the octave of the former fork. This is shown in a very beautiful way by an instrument devised by a Frenchman, Cagniard de Latour, and called a **siren**. It is shown in Figs. 188, 189. It consists of a metal box, the floor of which is pierced by a tube placed in connection with a large bellows. In the roof of the box is a small round opening, passing in a sloping direction. Fig. 189 shows a piece cut off the box so as to exhibit this opening. Above the fixed roof of the box, but very close to it, is a round plate, with a number of openings pierced in it, which slope in an opposite direction to that of the opening in the roof. This plate turns on a fine pivot, so that one hole after another can be brought opposite the opening in the roof. Fig. 189 shows one hole in the plate opposite the opening in the roof of the box, and the different slope of the two openings is seen. Fig. 188 shows the siren complete. Now if air be driven from a bellows into the box, it escapes by the opening in the roof; and as it rushes out it strikes against the edge of the hole in the plate, and the "puff" of the escaping air is heard. The plate, being easily moved, is by this means made to turn, and so the opening in the roof becomes blocked; but when the plate turns a little farther a second hole in it comes opposite the opening in the roof, the air again rushes out, produces another "puff," and drives the plate round a little farther. Again the opening is blocked, and with the continued turning of the plate it is again speedily opened. If the bellows be worked hard the plate will be driven round fast, and the opening in the roof will be opened and closed very rapidly. Every time it is opened a shock will be given to the atmosphere by the escaping puff of air. Fixed to the apparatus are two dials which mark the number of turns made by the revolving plate. If one knows how often the plate turns in a minute, and the number of holes in the plate, it is easy calculating how many shocks the air will receive in a minute. Now it is found that if the bellows be worked so feebly that the plate turns so slowly as not to open and close the hole in the roof sixteen times a second, the puffing sound is heard each time the air escapes. But if the hole in the roof of the box is opened and closed sixteen times a second, which would be effected if the plate were turning once a second, and if it were pierced with sixteen holes, then the sixteen puffs are not heard as separate sounds, but are blended together, and a low musical sound is heard. If the bellows be worked more and more quickly the plate turns faster and faster, the number of shocks given to the air in a second of time is increased, and the sound is heard to rise in pitch, until with the utmost speed of the plate it becomes a high shrill sound. It is possible, by means of the siren, to discover the number of vibrations made in a second by the limbs of a tuning-fork sounding a note of a certain pitch. Let the siren be worked till the sound produced is of the same pitch as that of the fork; then by noting the number of times the plate is revolving, as marked on the dials, the calculation may be made. The instrument shows conclusively how pitch of sound depends on the number of vibrations produced by the sounding body in a second of time.

Quality, kind, or character of musical sounds depends on something very different from loudness and pitch. We speak of a sound being harsh, or mellow, or rich, &c. We know that a note of the same pitch sounded on a piano, a trumpet, and a violin differs very markedly in quality, and that a note of the same pitch produced by the human voice differs from them all. Each instrument, that is to say, has a quality of its own. If a tuning-fork of the same pitch be sounded, we are aware of a great difference. The sound might be called thin, or poor, wanting in quality. It is, indeed, so wanting, for a tuning-fork produces what is called a pure sound. But suppose the tuning-fork vibrates 100 times per second, and that we take another vibrating 200 times a second; it will produce a sound the octave of the first. Let us take a third, vibrating 300 times, the octave of the second, a fourth, vibrating 400 times, and so on up to an eighth, vibrating 800 times per second; then we have a set of forks all related to the first in that they vibrate twice, thrice, four times, &c., as often as the first. If, beginning with the first, they are all sounded one after the other, we perceive the sound of each one immediately after it is produced, but the different sounds immediately begin to blend. When all are sounding we are not aware of eight different sounds, but of one sound of a definite pitch and peculiar quality. The pitch is given by the note of the one with which we began, which is called the **fundamental note**, and the particular quality is due to the blending of the other notes, which are called **overtones** or **harmonics**. The quality may be altered by causing only some of the forks to sound along with the first one; and it is mellow if the forks with fewer vibrations sound, while it is ringing if those with most vibrations are set going. The quality of the sound produced by a violin string is due, therefore, to it vibrating not only to produce the fundamental note to which it is tuned, but also vibrating so as to produce overtones. A piano wire tuned to the same pitch produces a different set of overtones, and thus has a quality of its own, and so with each different musical instrument. In the language of wave movement, the pianoforte wire and the violin string may produce the same *number* of waves in a second of time, but the *form* of the wave is different in each case, and so the quality differs.

These are the chief facts to remember regarding sounds. How the knowledge of them aids in the understanding of the structure of the ear and the perception of sound will be seen immediately.

THE ORGAN OF HEARING—THE EAR.

The Ear is to be regarded as an apparatus intended to be affected by waves of sound. Connected with it is the nerve of hearing—indeed the ear is to be considered as a peculiar form of nerve ending,—so that as soon as the ear is affected by sound the impression is conveyed along the nerve to the brain, and the sensation of sound is produced. Now the nerve of hearing, or auditory nerve, ends in a peculiar structure placed deeply, for protection, in the bones of the head. So deeply is this principal part of the organ of hearing placed that sounds cannot directly affect it. Some arrangement requires to be provided, therefore, for conveying or conducting the sounds inwards towards the nervous structure. The organ of hearing, therefore, consists of two parts:

1. A part for conveying sound inwards to
2. The nervous portion affected by sound.

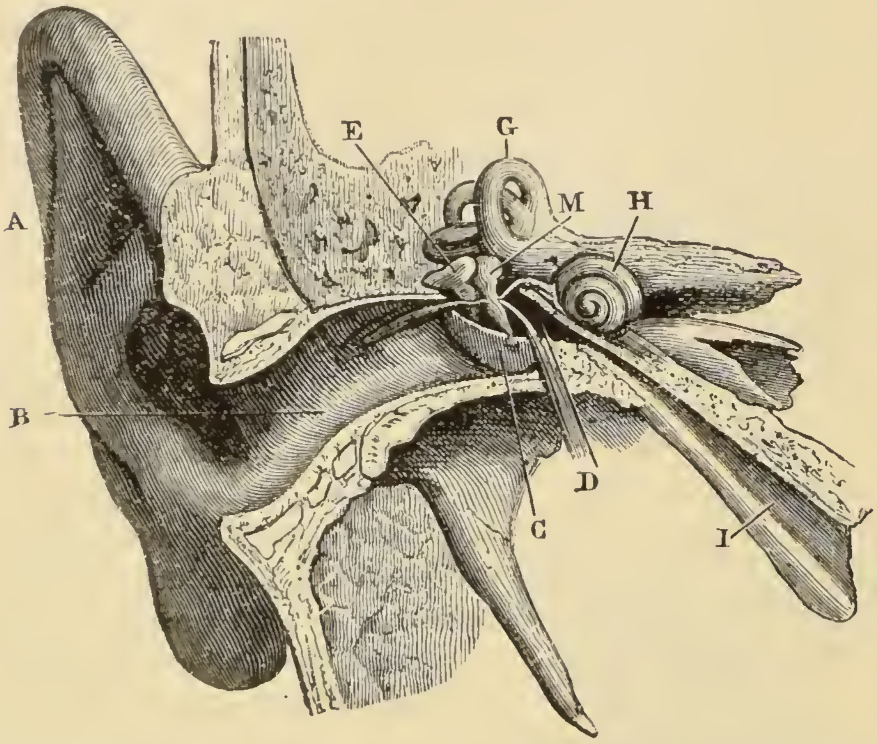

Fig. 190.—The Ear of the Right Side. A, Auricle; B, External Canal; C, Drum, partly removed; D, Cavity of middle Ear. E, Anvil, and M, Hammer—small bones of the middle Ear; H, Cochlea, and G, Semicircular canals of internal Ear. [These latter parts are buried in the temporal bone of the head.] I, Eustachian tube passing from the cavity of the middle ear to the throat.

The nervous portion is most deeply placed, and is called **the inner ear**, while the sound-conducting portion includes what are called the **outer ear** and **the middle ear**.

The Outer Ear consists of the appendage, or **auricle**, at the side of the head, and of a passage that leads inwards from it. The outer appendage is of a peculiar shape, which is not without its uses. For it has been shown that waves of sound falling on the outer ear are, owing to its peculiar curves, directed into the passage. The passage, or **external meatus**, is not straight but curved, and is about an inch and a quarter long. Near its outer portion are a number of fine hairs, which may help to prevent the entrance of insects, &c., while in the deeper parts of the canal, embedded in the walls, are a number of glands, resembling the sweat glands (p. 413) of the skin, which pour out a yellow waxy substance, the **ear-wax** or **cerumen**. This substance keeps the canal moist, and may be produced in excessive quantity—for example, owing to irritated conditions of the walls of the canal, as a result of cold—and the wax may collect in sufficient quantity to block the passage and produce dulness of hearing. It is plain that the business of the outer ear is to collect the waves of sound and conduct them inwards nearer to the inner ear, the true organ of hearing.

The Middle Ear.—At the end of the outer ear-passage is the **drum of the ear, or tympanum, or tympanic membrane.** It is stretched quite across the deep end of the passage, which it *completely closes.* It is a thin, unyielding membrane, oval in shape, not flat, but bulging slightly inwards a little below the middle. On the inner side of it is a small cavity, the **cavity of the middle ear**, or cavity of the drum of the ear. This is a small chamber, placed in one of the bones of the head (the petrous portion of the temporal bone, see p. 59), about half an inch in height, and one to two lines in breadth. Its bony walls are lined with mucous membrane—a membrane, that is, similar to that lining the nose, mouth, and throat. There are several deficiencies in its walls. In the outer wall an opening in the bone is closed by the drum. The drum, that is to say, is a partition between the passage of the outer ear on one side and the cavity of the middle ear on the inner side. On the inner wall of the chamber are two openings, one round, called the **round window**, or, in Latin, the **fenestra rotunda**; and another oval, the **oval window, fenestra ovalis**. On one side of the chamber is an opening leading into a tube, about an inch and a half long, the **eustachian tube**, partly made of gristle, and lined with mucous membrane similar to that of the chamber and the throat. This tube passes downwards into the back part of the throat. The tube is usually closed, but it is opened in the act of swallowing. If one firmly closes the nostrils, and performs the act of swallowing, a curious sensation of pressure is felt at the drum of each ear, there is a feeling of great fulness in the ears, and the hearing is not so sharp. If one swallows again, the nostrils being open, the sense of pressure and fulness passes away. The reason is, that by the act of swallowing the pressure of air is increased at the back of the throat; the nostrils being closed, the condensed air cannot escape that way, and rushes up the opened eustachian tubes into the cavities of the middle ear, bulging out the drums and producing the feeling of fulness and pressure. As soon as the act of swallowing is over, the tubes close and the air is imprisoned. If swallowing be again performed, the nostrils not being held, the tubes are again opened and the imprisoned air escapes.

It is important to notice that there is, in healthy conditions, no communication whatever between the chamber of the middle ear and the outside except by the eustachian tube. There is no opening between this chamber and the outer passage of the ear in ordinary circumstances, for the drum completely separates the two. But, as a result of disease or accident, an opening may be made in the drum, or the drum may be destroyed, and then, of course, the middle ear will communicate with the outside through the passage of the outer ear. Another important practical point is that the membrane that lines the throat is continuous up the eustachian tube with the membrane lining the middle chamber of the ear. Thus redness and swelling of the throat—a cold in the throat (see Catarrh, p. 214)—is usually accompanied by some degree of deafness, because the swelling passes up to the middle ear, and blocks the chamber.

A chain of small bones—the auditory ossicles—extends across the cavity of the middle ear, reaching from the drum in the outer wall to the oval window in the inner wall. These bones are three in number, and from their appearance were called **malleus**, or hammer, **incus**, or anvil, and **stapes**, or stirrup. They are shown in Fig. 191, the upper part showing the stirrup-bone, and the lower the bones connected. The resemblance of the third bone to a stirrup is striking. By the long downward projection (2) the hammer-bone (1, 2) is fixed to the inner surface of the drum of the ear, the projection at the side attaching it to the bony wall of the chamber in which it is lodged. The round head (1) of the hammer is connected with the anvil (3) by a movable joint, while the long projection of the anvil (4) is similarly connected with the stirrup-bone (5). The plate of the stirrup is fixed by membrane into the oval window of the inner wall of the chamber of the middle ear. Thus across this chamber this chain of three bones is stretched, placing the two walls of the cavity in communication. Moreover, on the inner side of the oval window is a cavity, part of the internal ear, where is lodged the essential portion of the organ of hearing. The membrane which closes the oval window, therefore, and to which is fixed the plate of the stirrup, separates the cavity of the middle ear from the internal ear.

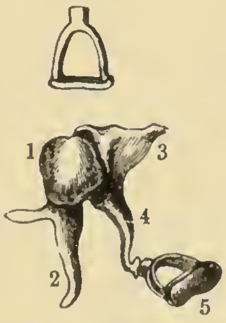

Fig. 191.—Ear-bones.

The purpose of the external and middle portions of the ear now becomes evident. Waves of sound are produced in the atmosphere about us. These waves reach us, and are directed by the appendage of the ear up the external passage, at the end of which they meet the drum. The drum is a thin membrane, and, when waves of sound beat upon it, it is thrown into vibration, reproducing, it is to be remarked, in its movements the characters of the sound-waves that have fallen upon it. But to the inner surface of the drum is attached one end of the chain of bones, and, since that chain is movable, the vibrations of the drum will be passed along the chain and reach the stirrup. The stirrup fits into the oval window by means of a membrane, and the stirrup and membrane will consequently be caused to perform to-and-fro movements at the oval window, passing the movement inwards to the structures of the internal ear beyond. Thus, by means of the external appendage, the external canal, the drum, and the chain of bones, the movements in the air caused by a sounding body are communicated to the internal ear.

It may be added that three small muscles are connected with the chain of bones. Two are connected with the hammer, one (the **tensor tympani**) so pulls on it as to tighten the drum to which it is attached, the other pulls in the opposite direction and relaxes the drum (the **laxator tympani**). One small muscle is attached to the stirrup (the **stapedius**) whose contraction prevents the stirrup being pushed too deeply into the oval window. The external and middle parts of the ear evidently form a *sound-conducting apparatus*. If the external passage be blocked by wax or other substances, if the drum be thickened by disease, injured or destroyed, or if the chain of bones loses its power of movement as the result of inflammation of the middle ear, partial or complete deafness of that ear is to be expected.

Having seen how sound is conducted to the internal ear, we must now see what arrangements exist in that part for receiving the sounds led to it.

The Internal Ear consists of a curiously shaped structure buried in the temporal bone (p. 59). It is represented in Fig. 192. The opening, marked 2, is that of the oval window, on the inner wall, as we have seen, of the cavity of the middle ear, and closed by the stirrup-bone and its membrane. This opening leads into a small chamber, about $\frac{1}{5}$th of an inch in diameter, called the **vestibule.** From the back part of the vestibule there open three tubes, the **semicircular canals,** so called because of their shape, which are $\frac{1}{20}$th of an inch in width and make a curve of about $\frac{1}{4}$th of an inch in diameter. One is directed horizontally (4), another upwards (3), and the third backwards (5). Opening from the vestibule by these separate openings, they also join it again. The upper and back one are united at the other end and rejoin the vestibule by a common opening. Thus there are five openings connected with the canals. Each canal has a bulging part at one end called an **ampulla,** marked thus * in the figure. From the fore part of the vestibule there passes a tube, which makes two and a half turns, coiling like a snail's shell. It is termed the **cochlea** (6, 7, 8, Fig. 192). At the base of the cochlea is the opening of the **round window** (9, Fig. 192) which communicates with the cavity of the middle ear (p. 464), but in the recent state is closed by a membrane. Besides the openings already mentioned the vestibule has several small apertures in its inner wall, by means of which there enter branches of the nerve of hearing—auditory nerve (p. 152). All these parts, vestibule, semicircular canals, and cochlea, are formed of bones, and to the whole structure the term **bony** or **osseus labyrinth** is applied. The inner surface is lined by membrane, and the labyrinth contains a fluid, the **perilymph.**

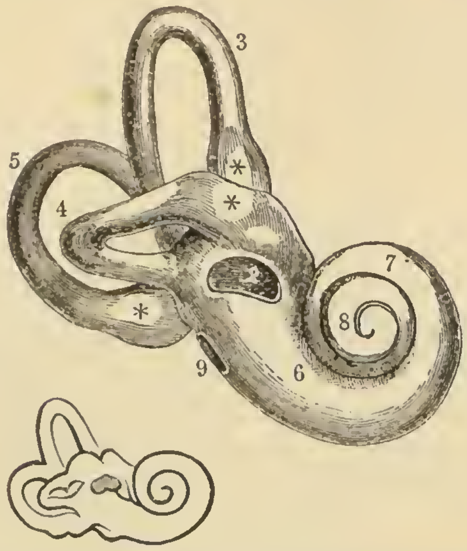

Fig. 192.—Bony Internal Ear of the right side; the upper figure magnified, the lower of the natural size.

But this bony labyrinth forms only an outer casing for a membranous labyrinth. Fig. 193 represents the complete membranous labyrinth. It is formed of two sacs which are lodged in the bony vestibule. The larger of these sacs (*d*) is called the **utricle,** the smaller the **saccule** (*e*). These, it is to be remembered, are lodged in the bony parts described, and separated from the bony walls by the fluid—perilymph—contained in the bony labyrinth. Passing off from the utricle (*d*) are membranous semicircular canals (*a*, *b*, *c*), lying in the bony canals of the same name, surrounded by the perilymph. The inner surface of the utricle and membranous canals is lined by epithelial cells (p. 54), and from the surface fine hairs project into the interior, which contains a fluid—the **endolymph.** Branches of the nerve of hearing pass to the sac and canals, and are supposed to be in connection with the hair-like processes. The nerves are specially distributed to the sac and the bulgings of the membranous tubes. Now if these hair-like processes are connected with nerve-fibres, the slightest agitation of the fluid in the membranous canals will disturb the hairs and consequently affect the fibres of the nerve of hearing. Within the sac of the utricle are found minute crystals of carbonate of lime—**otoliths**—which may be supposed, on disturbance of the fluid, to affect more strongly the hair-like projections from the walls.

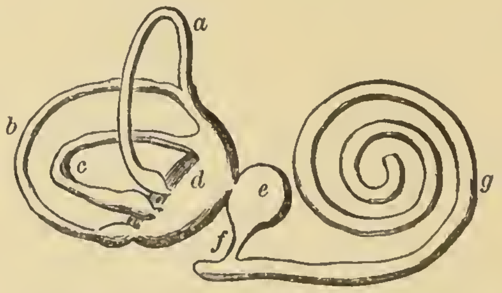

Fig. 193.—The Membranous Labyrinth.

The smaller sac, the saccule (*e*), lodged also in the bony vestibule, communicates by a fine canal (*f*) with the membranous canal (*g*) contained in the shell-like cochlea, and called the **canal of the cochlea.** Further, it is found that the two sacs communicate with one another by a very fine tube, so that the whole membranous labyrinth is connected together.

The **membranous canal of the cochlea** (*g*) is the most important part of the internal ear, since in it is lodged the apparatus that is believed to be the chief agent in the perception of sound. It has already been mentioned that the cochlea possesses an outer bony case, resembling in appearance the shell of a snail (6, 7, 8 of Fig. 192), but we must now describe this bony part rather more particularly. If the cochlea be opened into, there is seen to be a central bony pillar, round which the bony tube is wound two and a half times. The central bony pillar is called the **modiolus.** The bony tube is not regular inside. From that part of it which lies against the central column, as it winds round, there projects inwards a bony ridge—the **lamina spiralis.** At the base of the bony cochlea, just where it begins to wind round the modiolus, this ridge projects well into the space of the bony canal, dividing it almost into two compartments; but, as the bony canal winds round the column, the lamina spiralis, which, of course, follows the turnings, becomes less and less projecting, till at the blind end of the bony cochlea it is not nearly so prominent. Fig. 194 shows the cochlea with part of the wall removed to show the interior. From E straight downwards is the direction of the central column—modiolus—to which D points; B B point to the projecting ridge—lamina spiralis—almost dividing the canal of the tube into an upper compartment C and a lower A. (Refer also to Fig. 195.) Now in the recent state this partial division of the tube is completed by membranes, so arranged as to form a membranous canal within the bony one—the **membranous canal of the cochlea.** This will be understood from Fig. 195. This represents the cochlea cut straight down from top to bottom. M is the central column; A, B, C, and D are complete sections of the bony cochlea, in different parts of its winding, cut across. In each cross section L points to the lamina spiralis, projecting inwards from the central column. From the edge of this ridge two lines (1 and 2) are seen passing outwards, and diverging as they pass, to the outer wall of the bony canal. These are membranes; the lower (1) is called the **basilar membrane,** the upper (2) is the **membrane of Reissner.** These two membranes thus complete the division between the upper and lower part of the bony tube. The upper division (S.V.) is termed the **scala vestibuli** (the staircase of the vestibule), the lower (S.T.) is the **scala tympani** (the staircase of the tympanum). Inasmuch, however, as the two membranes separate from one another as they pass across, they inclose between them a triangular space. It is this space (S.M.), formed by the basilar and Reissner's membranes and the part of the bony wall between them, that constitutes the membranous canal of the cochlea, or the **scala media** (middle staircase) of the cochlea. This part of the bony wall is, like the rest of it, lined by a membrane. Thus we have the bony cochlea throughout its two and a half turns divided into three compartments; and within the bony canal of the cochlea we have a membranous canal, occupying only a small part of the space. Now at the base of the cochlea, that is, at the beginning of the first turn, the scala of the vestibule opens into the bony vestibule already described, while at the foot of the scala of the tympanum is the round window, closed and separated from the cavity of the middle ear by a membrane. As we have seen, the vestibule has an opening in its wall—the oval window—on the outer side of which is the cavity of the middle ear, but which is closed in the bony state by the stirrup-bone and its membrane. At the top of the cochlea the scala vestibuli and the scala tympani communicate with one another by a small opening called the **helicotrema.**

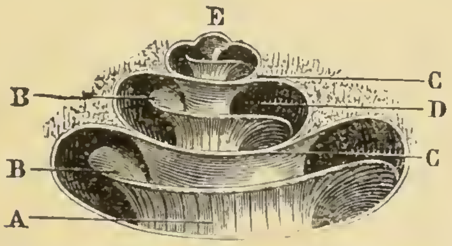

Fig. 194.—The Cochlea opened up (magnified).

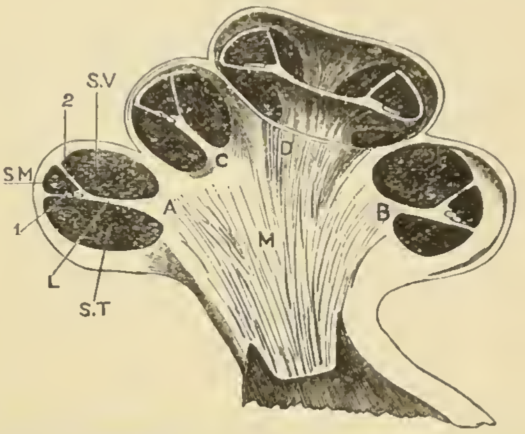

Fig. 195.—Vertical Section of the Cochlea of a Fœtal Calf.

Suppose, then, we begin with the external canal of the ear. Passing up it for an inch and a quarter we reach the drum. On the inner side of the drum is the cavity of the middle ear, across which stretches the chain of small bones, one end of which is attached to the inner surface of the drum, and the other end of which—the stirrup—is inserted into the oval window. On the inner side of the oval window is the bony chamber of the vestibule, opening from which is the scala vestibuli. Entering this staircase, we pass round two turns and a half to the top of the cochlea. Part of the floor of this scala is the membrane of Reissner, which is also the roof of the scala media. Reaching the top we pass through the small opening of the helicotrema and enter the scala tympani, down which we pass two turns and a half. Part of the roof of this staircase is the basilar membrane or floor of the scala media, which is thus inclosed between the two staircases. Arrived at the foot of the scala tympani, we reach the round window, closed by a membrane, on the outer side of which is the cavity of the middle ear.

Next it is to be observed that the scala vestibuli and scala tympani are both filled with a fluid—perilymph. Consequently waves of sound in the atmosphere pass up the external passage and throw the drum of the ear into vibration. These movements are conducted across the chain of bones to the oval window, and cause the stirrup-bone to make to-and-fro movements at the window. These throw the fluid in the vestibule into vibrations, which pass up the one staircase and down the other and are spent at the round window. As these waves pass along the fluid they communicate movement to the membrane of Reissner, the floor of the vestibule staircase, and to the basilar membrane, the roof of the tympanic staircase. These membranes are respectively the roof and floor of the middle scala or membranous canal, and this canal also is filled with fluid—endolymph—which is consequently agitated. Consequently the vibrations of a sounding body ultimately communicate movement to the fluid contained in the membranous canal or middle staircase.

The membranous canal of the cochlea then lies in the bony cochlea, inclosed between the two staircases, but it does not open into either. At the top of the cochlea it ends blindly. Its base lies in the bony vestibule, but does not open into it. By a small canal (*f*, Fig. 193), however, it has connection with the saccule.

Within this membranous canal and resting on the basilar membrane is a remarkable structure, first described by the Marquis Corti, and hence called **Corti's organ**. It is a very complicated structure, which it is needless to try to describe here. It consists mainly of a series of fibres—**fibres of Corti**—each made of two parts resting against one another so as to form an arch. These arches are placed, side by side, in a continuous series along the whole length of the basilar membrane. In the human ear it has been estimated that there are no less than 3000 of such arches. When viewed from above downwards by a microscope, they present the appearance of the key-board of a piano. Fig. 196 shows a few of the arches side by side, B of the figure exhibiting two fibres forming an arch. It would appear that the arches are supporting structures, for, resting on them are numbers of conical epithelial cells (p. 54), from the free surface of which bundles of stiff hairs project. It is believed that these hair cells are the true sound-perceiving structures.

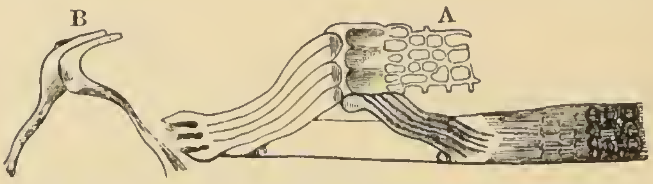

Fig. 196.—Arches of Corti's Organ (very highly magnified).

We have seen how vibrations of a sounding body reach, in the end, the membranous canal of the cochlea, containing Corti's organ. The fluid contained in this canal will be thrown into vibrations, and these in turn will affect the hairs of the cells supported on Corti's rods. These hair cells are in communication with nerve-fibres, which pass into Corti's organ through channels in the modiolus, or bony pillar round which the cochlea is wound. Thus the vibrations communicated to the hairs will affect the nerve-fibres, and cause impulses to be sent along the nerves to the brain, resulting in sensations of sound.

THE SENSE OF HEARING.

The Perception of Sound.—The description that has been given of the very complicated structure of the ear will enable one to perceive how sounds are conveyed into the depths of the ear, but it is extremely difficult to understand how that apparatus enables us to have knowledge of all the multitude of various sounds of which we are daily conscious.

We must go back again to the physical world to get light on the difficulty. It is a well-known fact that if one takes two tuning-forks, such as are used for experiment in a natural philosophy laboratory, both tuned to sound exactly the same note, and if the forks are placed at some distance from one another, and one of them is made to sound, the other not being touched, in an instant both will be heard sounding. The sound of the one fork has set the other agoing. This, it must be noticed, happens only if both utter a note of the same pitch. If the two forks sound different notes, the one may be set humming loudly and long, the other remains dumb. But if the two are tuned to the same note, the one is no sooner set sounding than the other is heard humming also. This is called **sympathetic vibration**, but there is no mystery about the occurrence. The one fork produces waves exactly similar to those the other would produce. When, therefore, one is sounded, the waves pass out and reach the other fork, against which they strike. Wave after wave hitting on the fork, each wave exactly suiting the swing the fork makes when in motion, gradually sets it into vibration. It is just like a small boy setting in motion a swing on which a heavy boy is sitting. If he tried to make it give a big swing with one push, he might push with all his might and accomplish nothing. If he be a wise small boy, however, he does not attempt this. He gives the swing an ordinary push, and it swings slightly. He waits till it has moved forward, then backwards, and, just as it is about to sway forwards again, he gives it another push, which, added to its own impulse, increases its movement. So he goes on till, in a short time, he has it in full swing. But if he does not time his pushes properly he will speedily stop the swing. It is the same with the tuning-fork. Each wave from its neighbour reaches it at the proper time and speedily sets it in full vibration. If now the second fork have one limb loaded, say with a piece of wax, the note of the fork is flattened. It is no longer in tune with the first one, and can no longer be set in sympathetic vibration with it, because its swing is no longer in time with the waves of its neighbour. One fork, therefore, can be set in vibration only by another sounding exactly the same note; and the fork will recognize its own note and hum in harmony with it, though the sound reach it from a considerable distance.

Suppose, then, that, on a table at one end of a room, one had a set of tuning-forks, each tuned to a particular note. Let a number of musicians proceed to play on their instruments at the other end of the room. No matter how complex the body of sound they produce, each tuning-fork will pick out infallibly its own note from the mass of sound, if its own note happens to have been produced; and if the players suddenly cease, the tuning-forks will be heard sounding. By finding which of them are vibrating, one can tell what notes were produced by the players. Suppose one could have a set of tuning-forks so numerous that there was one for every note that could be sounded, it is evident one would have here an apparatus for analysing the complex sound, that is, splitting it up into its elements. One may try a simple experiment of this kind with a piano. Let the damping pedal be lifted from the wires, and let someone sing loudly in the room, and then suddenly stop. Some of the pianoforte wires will be heard sounding. They have picked out of the song their own notes, and have been set in sympathetic vibration by them.

Now it is believed that it is somewhat after this fashion that the internal ear perceives sound. It has been noted (p. 468) that, in the internal ear, the organ of Corti contains a large number of cells with hairs projecting from them. It is supposed that each hair is sensitive to a particular vibration. The vibrations of a sounding body are conducted to the internal ear in the manner already described, and agitate the fluid in the membranous canal of the cochlea. The waves produced will be complex waves, compounded, that is, of simple waves of different lengths, &c. Each hair, however, will vibrate in harmony with one particular simple wave, and if that one be contained in the complex one, it will pick it out and vibrate to it. Thus the complex wave of sound will be split up into simpler forms, each hair selecting and vibrating to its own, and a multitude of hairs will be set simultaneously vibrating by the mass of sound. The ear is thus an organ that analyses (splits up) sounds into their elements.

In support of this view it may be mentioned that hairs on the feelers of the Mysis, an animal belonging to the same general class as crabs and lobsters, have been seen to vibrate in harmony with particular notes and with these notes only.

Each hair cell is in communication with a nerve-fibre, and the vibration of each hair will thus cause an impression to be passed along a nerve. The various impressions will be passed along to the hearing centre in the brain, where they become fused, and the person is conscious of a sound of a particular kind. While the ear splits up complex sounds, and communicates to the brain the elements of which they consist, the brain reunites them. We are not conscious of the splitting-up process but only of the union.

The Range of the Ear for musical sounds has been determined to be from 32 to about 30,000 vibrations per second. That is to say, 32 vibrations per second produce the sensation of a low musical note, the lowest the human ear can appreciate, while vibrations occurring at the rate of about 30,000 per second produce the sensation of a very high pitch, the highest the human ear can appreciate. Vibrations more rapid cannot be taken knowledge of by the ear.

The Sensation of Discord in music is due to the interference of two sounds which are nearly of the same pitch. As two waves in water may abolish one another if the crest of one meets the hollow of another, and may again add to one another's size by the two crests meeting, so two waves of sound differing slightly from one another may at one moment almost extinguish the sound by interference, and at the next produce increased loudness of the sound by being added to one another. The result is the production of what in music is called **beats**, characterized by a rising and falling of the sound. The effect on the ear is similar to the effect of a flickering light on the eye. When the beats occur with sufficient rapidity they give a sensation of roughness to the sound, greatest when they number 33 in a second. When they reach the number of 132 in a second they are no longer perceived. Two notes that, when sounded together, produce beats are recognized as discordant notes.

Judgments of the direction of sound are not actually performed by the ear; they are the result of various other circumstances. Anyone can prove this by shutting the eyes and trying to decide the direction from which a sound is coming. The distance from which a sound proceeds we judge of by its loudness or faintness. It is such facts as these that the ventriloquist takes advantage of to deceive people. He imitates the character of sound from a distance, or from some particular place, by giving it the required degree of loudness, and by directing the attention of the person to that quarter, &c., his own face at the same time giving no sign of movement.

"Educating the ear" is a phrase which derives force by all that is known about the mode of action of the organ of hearing. We have seen that the ear actually analyses or splits up sounds into their simple elements, and that the brain fuses the elements together again. The habit is to pay attention only to the fused sensation. But we all know that the trained musician detects the elements of a complex sound, while the person who has given no attention to his sensations knows only, perhaps, that the sound is pleasant or the reverse. Just as surely as every ear performs the same process of analysis, so may every person, by careful training, become able to perceive something of the analysis, and to detect some of the varied elements of musical sounds that he listens to. The difference, indeed, between a "good ear" and a "bad ear" is to a large extent the difference between careful training and bad training, or no training at all. Something, of course, must be admitted to natural aptitude; but the excuse many people offer for their ignorance of music, that they have "no ear," is no excuse at all, in view of the facts that have been stated—is, indeed, but another way of implying carelessness and neglect. Just as the man, who is not blind, would be laughed at if he offered, as an excuse for being unable to read, that he had no eye, so ought a person, who is not deaf, to be laughed at if he offers, as an excuse for being unable to distinguish one note from another, or different notes in a chord, that he has no ear.

SECTION XXIII.

THE SENSES AND SENSE-ORGANS.

THEIR DISEASES AND INJURIES.

Affections of the Sense of Touch.

Loss of Sensibility of the Skin (Anæsthesia);
Increased Sensibility (Hyperæsthesia);
Perverted Sensibility (Paræsthesia).

Affections of the Sense of Taste.

Excessive or Perverted Sensitiveness of Taste;
Loss of Taste.

Diseases and Injuries of the Nose and Affections of the Sense of Smell.

Diseases of the Nose:

- *Cold in the Head;*
- *Chronic Discharge from the Nostrils;*
- *Stink-Nose (Ozæna)*;
- *Ulceration in the Cavity of the Nostrils;*
- *Tumours of the Nose; Polypus.*
- *Foreign Bodies in the Nostrils;*
- *Bleeding from the Nostrils (Epistaxis)*;
- *Injury to the Nose;*
- *Sneezing.*

Affections of the Sense of Smell.

- *Loss of the Sense of Smell (Anosmia)*;
- *Over-acuteness of the Sense of Smell.*

Diseases and Injuries of the Eye and Affections of the Sense of Sight.

Diseases of the Eyelids:

- *Skin Affections of the Eyelids;*
- *Inflammation round the Eyelashes (Blepharitis)*;
- *Turning outwards or inwards of the Eyelids (Ectropion and Entropion)*;
- *Stye (Hordeolum)*;
- *Tumour of the Eyelid (Chalazion)*;
- *Inflammation of the Inner Surface of the Eyelids (Cold-in-the-Eye—Conjunctivitis)*;
- *Pustules (Phlyctenæ)*;
- *Thickening of the Lining of the Lids (Granular Lids—Egyptian Ophthalmia—Trachoma)*;
- *Burns—Symblepharon* and *Anchyloblepharon*, or unnatural union of the lids to the eyeball and to one another;
- *Foreign Bodies within the Eyelids;*
- *Drooping of the Eyelids (Ptosis)*;
- *Inability to shut the Eyelids;*
- *Twitching of the Eyelids;*
- *Bruises and Wounds of the Eyelids.*

Diseases of the Tear Apparatus:

- *Obstruction of the Tear Passage.*

Diseases of the Eyeball:

- *Inflammation of the Cornea (Keratitis)*;
- *Abscess and Ulcer of the Cornea;*
- *White Spots on the Cornea (Opacities)*—The operation for artificial pupil (*iridectomy*);
- *Staphyloma;*
- *Foreign Bodies in the Cornea;*
- *Wounds of the Cornea;*
- *Inflammation of the White (Sclerotic) of the Eye;*
- *Inflammation of the Iris (Iritis)*;
- *Cataract*—The operation for its cure;
- *Diseases of the Retina, Choroid Coat, and Optic Nerve (Retinitis—Choroiditis—Optic Neuritis)*;
- *Separation of the Retina (Dropsy of the Retina)*;
- *Glaucoma;*
- *Examination of the Eye by the Ophthalmoscope;*
- *Foreign Bodies within the Eyeball*—Sympathetic Inflammation;
- *Rolling Eyeballs (Nystagmus)*;
- *Squint (Cross-eyes—Strabismus).*

Affections of the Sense of Sight:

- *Short-sight (Myopia) and Long-sight (Hypermetropia)*—Treatment by Spectacles;
- *Weak-sight (Asthenopia)*; *Defective Sight from Age (Presbyopia)*;
- *Astigmatism;*
- *Blindness (Amaurosis and Amblyopia)*; *Partial Blindness of One Eye (Hemiopia)*;
- *Night-blindness (Hemeralopia)*—Snow-blindness and Moon-blindness;
- *Colour-blindness (Daltonism)*;
- *Double Vision.*

The Care of the Eyes.

Diseases and Injuries of the Ear and Affections of the Sense of Hearing.

Diseases and Injuries of the Ear:

- *Diseases of the Auricle;*
- *Inflammation of the Canal of the Ear*—Boils in the Canal;
- *Wax in the Ear to Excess*—Syringing the ears;
- *Growth in the Canal of the Ear (Polypus)*; *Foreign Bodies in the Ear;*
- *Inflammation of the Drum;*
- *Injury to the Drum*—Bursting of the drum by blows. diving, &c.;
- *Inflammation of the Middle Ear;*
- *Earache;*
- *Discharge from the Ears (Running Ears)*;

Affections of the Sense of Hearing:

- *Deafness;*
- *Noises in the Ears.*

Deaf-Mutism.

Care of the Ears.

AFFECTIONS OF THE SENSE OF TOUCH.

There are two main diseased conditions of the sense of touch, one in which the sense is abolished, which is called **anæsthesia** (Greek, *a* not, *aisthanomai*, to feel), and the second in which the sense is unnaturally acute, called **hyperæsthesia** (Greek, *huper*, in excess). The sense may also be perverted.

Loss of Sensibility of the Skin (*Anæsthesia*) may be due to disease of the nerves of sensation supplying the skin, or to disease of the nerve-centres, namely, the brain or spinal cord. Thus pressure of a tumour on a nerve, injury to a nerve, may produce it, while it is often produced in apoplexy and other brain diseases.

Sometimes the action of irritating substances on the skin will produce a numbness, though not exactly a total loss of sensation.

One remarkable form of loss of sensibility occurs in hysteria. In it the sense of touch, including sensations of contact, of heat and cold, and of pain, is lost on the whole of one side of the body, so that pins may be thrust into the body on one side without producing any evidence of feeling on the part of the patient. As soon as the middle line of the body is crossed, however, the sensibility is found perfect. Indeed the dividing line between the sensitive and not sensitive portions of the body is remarkably sharp. This affection is called **hemianæsthesia**, from its being limited to one half of the body.

The recognition of the cause of this disease and its appropriate treatment are subjects of considerable difficulty. The disease is essentially a nervous one.

Increased Sensibility (*Hyperæsthesia*) may be to touch proper or to pain. In some cases it is so marked that the slightest touch produces a feeling of intense pain. It occurs in connection with neuralgia, hysteria, and gunshot injuries of nerves. The increased sensitiveness may be to heat or cold.

Perverted Sensibility may be shown by contact with hot or cold objects being felt not as sensations of heat or cold but of pain. There may be feelings of burning or tingling in the skin, feelings as of the creeping of insects over the body, &c. This also is a nervous disorder. It is called **paræsthesia**.

AFFECTIONS OF THE SENSE OF TASTE.

Excessive or Perverted Sensitiveness of taste may occur. An extremely small quantity of some substance may give rise to an intense impression on the taste sense, or a very prolonged impression, or quite a different impression may be made from what is natural. Such cases are met with in the hysterical and insane. Further, tastes may be felt quite apart from any substance taken into the mouth, as a result of irritation of the nerves of taste, by disease for example. Certain substances present in the blood will cause a taste to be felt. The taste of some substances may be felt when they have been injected under the skin and not taken into the mouth at all. Everyone also knows how disordered conditions of stomach and bowels give rise to bad tastes in the mouth.

Loss of Taste occurs in hysteria and nerve affections. Thus it may result from rheumatic inflammation of certain nerves that supply the mouth and face. It may be associated with paralysis of the face, and may be lost only on one side of the tongue. Since the tongue is supplied by two nerves, so far as taste is concerned, one supplying the front part and another the back part (see p. 445), the sensibility of one part may be lost and that of the other retained. Loss of taste may also arise from no affection of nerves, but from thickening of the surface of the tongue or mouth rendering the ends of the nerve-fibres less easily affected by the tasty substance.

Affections of the tongue have been considered on p. 210.

DISEASES AND INJURIES OF THE NOSE AND AFFECTIONS OF THE SENSE OF SMELL.

DISEASES AND INJURIES OF THE NOSE.

Cold in the Head, or nasal catarrh, which usually begins by attacks of sneezing and then goes on to a free discharge from the nostrils, has been sufficiently described under CATARRH (p. 214).

Chronic discharge from the nostrils is frequently the result of chronic catarrh, that is, of repeated attacks of cold in the head. As a result the person is annoyed by a thick discharge, or by swelling of the lining membrane, causing "stopped nose," thickness of speech, defective smell, &c. A chronic discharge from the nostrils is a feature of glanders, a disease of the horse communicable to man. It is mentioned under FEVERS.

Treatment consists in using as a snuff a powder of bismuth and alum or chlorate of potash, diluted with five or six parts of powdered starch or gum-arabic. A lotion may be used made of borax, alum, and tannin, or chlorate of potash, in the strength of 10 grains to ½ ounce of water and ½ ounce of glycerine. Some of this should be thrown into the nostrils by means of a syringe consisting of a small elastic ball with a short glass nosepiece. Best of all is the use of the nasal douche (Plate XXXII.), tepid water, containing a half tea-spoonful of bicarbonate of soda and half that quantity of table salt to the pint, being by it caused to flow through the nostrils up one side and down the other.

Stink-Nose (*Ozæna*) is the term applied to the condition in which the discharge from the nostrils is very offensive. It often depends on ulceration of the nostrils high up, and may be attended by a sense of weight or fulness high up. It may begin with some foreign body which has passed up the nostrils and lodged, setting up inflammation and ulceration by its continued presence, and ultimately leading to disease of bone. Every case of stink-nose in children should be carefully examined for some foreign body, which the child may have pushed up the nostrils. After bleeding of the nose a large clot of blood may be retained and cause, in time, an offensive discharge. Various diseases may also be the cause of ozæna—syphilis, for instance.

Treatment.—First of all care should be taken that the cause of the mischief is not a foreign body. This is necessary specially in the case of children. The nostrils should be regularly cleansed by syringing, or by the use of the nasal douche (Plate XXXII.). The person stands with his head slightly bent over a basin. The nozzle is inserted into one nostril (*the healthy one*), the other being left free. The patient keeps his mouth open, breathing through it, and not permitting himself to perform the act of swallowing. If, now, the water be turned on, it passes through one nostril to the back of the throat, passes out by the opening at the back (see p. 195), does not go down into the throat but enters the back opening of the other nostril and washes through it, coming out at the front, where it is caught by the basin. By this method, *provided the patient breathes through his open mouth and does not swallow*, both nostrils can be washed thoroughly. If the person cannot get used to this method he may employ any small syringe.

Along with the washing out, by whatever method accomplished, lotions of various kinds may be used. One or two tea-spoonfuls of solution of chlorinated soda to a pint of water is useful in very offensive cases, or a weak solution of Condy's fluid, water made just pink with it, or solution of carbolic acid 1 ounce to 60 or 80 of water—3 or 4 pints. A useful paint for injecting by a syringe is glycerine with iodine, 1 grain of iodine dissolved in 1 ounce of glycerine.

Besides such local treatment the patient will often be benefited by taking cod-liver oil, quinine wine, tonics, &c.

Ulceration in the cavity of the nostrils will be attended by offensive discharge, and is to be treated as "Stink-Nose." If the ulcer can be reached by the finger an ointment of one part of iodoform and four of vaseline should be applied. Long-continued ulceration sometimes eats through the division between the nostrils, destroying bone and gristle. This is usually the result of syphilis.

Tumours of the nose.—The commonest tumour in the nostrils is what is termed **poly-**

pus, a growth from the lining membrane, of varying size, hanging as it were from a stalk.

Symptoms.—A polypus usually blocks the nostrils, so that the person has to breathe through the mouth, which is constantly kept open. The voice is generally altered and acquires a nasal twang. The finger may detect the growths, which feel like a bunch of earthworms.

Treatment.—The best treatment is removal by a surgeon. Washing the nostrils, by means of a syringe, with water containing a small quantity of salt or bicarbonate of soda (30 grains to the pint) relieves.

Warts may occur in the nose; they usually occur just within the nostril. They should be treated as advised for warts on p. 430. **Cancerous** and other tumours may also be present in the nostrils.

Foreign bodies in the nostrils are not uncommon in children. Cherry-stones, peas, and even nails are often pushed into the nostrils by them. Sometimes the child says nothing about it till, after a longer or shorter time, the presence of the foreign body has set up irritation, and produced discharge, which is usually offensive. Delay always renders the removal more difficult, since the substance becomes surrounded by secretion and is firmly lodged. Persistent discharge should always lead to an examination for a foreign body.

Treatment.—Let the free nostril be closed, and cause the person to blow through the blocked nostril as strongly as possible. If this fails, as it often will if the substance has been in the nostril some time, a stream of water may be employed. The nostril may be syringed from the front. If the person is old enough, the method of washing out the nostrils described on p. 473 may be used, the tube being inserted into the *sound* nostril, so that the water flows on the blocked side from behind forwards. Instruments should not be used except by a surgeon. If the aid of a hairpin is likely to extract the foreign body, it may be used, *but always the looped end*; the sharp point should always be avoided.

Bleeding from the nostrils (*Epistaxis*), occurring without any apparent cause, is rather common among young people. In girls it may be a source of relief at the monthly periods. Besides such cases it may attend the onset of typhoid fever, typhus, remittent, and scarlet fever; and it is a prominent feature in scurvy, purpura hæmorrhagica (p. 317), and other diseases. It may be due to diminished atmospheric pressure, and from this cause occurs to persons in ascending high mountains. The flow comes from one nostril, as a rule, and rarely from both at once. It may, as everyone knows, be due to injury.

In severe cases much loss of blood may take place, and fainting result, while frequent attacks may rapidly reduce a person's strength.

Treatment.—Let the nostril be firmly closed by pressure with the hand for several minutes, the head being held high. Cold, in the form of cold-water cloths, applied to the nose, neck, and forehead are very useful, iced cloths being still more effective. If measures like these are useless, plugging the nostril must be resorted to. This is done with pieces of lint rolled into the form of a cone and pressed in from the front. Sometimes it is necessary to plug from behind, but only a surgeon can do this.

Should attacks be common, the patient ought to have tincture of steel and quinine administered for some time.

Injury to the nose.—Fracture of the bridge of the nose as the result of a blow may be recognized by the alteration of shape, and by the grating feeling if a finger be gently pressed on each side of the bridge. The broken nose may often be restored to its proper position by gently moulding with the fingers. If the bones are pressed down they may be lifted by carefully passing up the nostril something like the bone or ivory handle of a pen or pencil-holder. If necessary, some cotton-wool may then be passed up to keep the bones from falling in again. On the outside the application of strips of sticking-plaster may help to keep the parts in place. *Immediately* after the blow, cold cloths are useful in keeping down bleeding and swelling; but *some time* after, hot cloths, freely applied, reduce swelling and pain rapidly.

A bruise on the bridge of the nose, without injury of bone, is best treated by hot cloths. When swelling has disappeared the soft parts may be adjusted as well as possible by narrow strips of skin-plaster.

Sneezing may become uncontrollable, so as to be actually a disease. The ordinary explanation of sneezing is that something irritates the lining membrane of the nostril, and the sneeze is designed to expel the cause of the irritation (see p. 353). Excessive sneezing occurs in hay-fever (p. 367), due, it is supposed, to the irritation set up by the pollen of certain plants. It is a common sign of the onset of cold-in-the head. It is, however, sometimes associated with whooping-cough and asthma, gout, and hysteria. It sometimes occurs connected with disturbance of sexual functions in women and connected with pregnancy.

Treatment.—Some sensitive point can usually be detected by a surgeon, which is the cause of the condition, touching of which by the electric cautery cures. A 5-per-cent solution of cocaine in fine spray (see Plate XLVII.) may succeed in diminishing the irritability, or an ointment of menthol (10 per cent) and cocaine (2 per cent) in white vaseline.

AFFECTIONS OF THE SENSE OF SMELL.

Loss of the Sense of Smell (*Anosmia*) may be due to unusual conditions of the lining membrane of the nostrils, such as swelling, thickening, &c., resulting from chronic catarrh (p. 473), or the presence of growths preventing the proper entrance of air, or to altered conditions such as may be induced by constant snuff-taking. A second class of causes includes such as affect the nerve of smell—the olfactory nerve (p. 151). A blow on the head may abolish the sense of smell by injury to the nerve. Abscesses, disease of bone, may act in the same way. While, in a third class of cases, loss of smell is caused by disease in the brain affecting the nerve-centres for smell.

The loss may be on one side only. Loss of smell will also be accompanied by loss of flavour, since flavour includes smell as well as taste (p. 445).

Treatment is directed to the cause. Cases of chronic catarrh should be treated as advised on p. 473 for chronic discharge.

Over-acuteness of the sense of smell occurs in hysteria, and as a result of weakness from chronic disease. Further, sensations of smell may be experienced without any external cause. One might call them delusions of smell. Thus a constant sense of a bad odour has attended disease of the brain and other diseases also.

DISEASES AND INJURIES OF THE EYE AND AFFECTIONS OF THE SENSE OF SIGHT.

DISEASES OF THE EYELIDS.

Skin Affections of the Eyelids.—Like the rest of the covering of the body the eyelids are liable to various skin affections. These are sufficiently discussed in Section XXI. One only need be mentioned here. It consists of an eruption of blebs, filled with clear fluid at first, but later with yellow matter. They spread from the inner part of the eyebrow over the forehead and up among the hair, and also downwards over the eyelids and the side of the nose. They are accompanied by severe pain and swelling and inflammation of the eye. The lids are so swollen that the eye is closed. This is an eruption quite similar to shingles, and properly called by the same name—**herpes**. It is treated in a similar manner (p. 424).

Inflammation round the Eyelashes (*Blepharitis*).—This is really an inflammation of the hair-sac from which an eyelash springs. It begins in little swellings on the edge of the lid round a hair, and rapidly spreads along the edge. Crusts form which stick to the lid, mat the hairs together, and produce a very unsightly appearance. The lids become thickened and red. Little points of matter often form. If the disease lasts long, the lashes fall out, so that the lids may be entirely deprived of lashes. Owing to the thickening the lids are turned outwards; the tears no longer readily escape into the opening of the tear passage, and the eyes are constantly overflowing. The inflammation may spread over the inner surface of the lids and reach the eyeball; and the constant irritation of the tears, discharge, &c., may also produce ulcers on the front of the ball.

Treatment, if early adopted and persevered in, will readily cure the affection in its first stages. *The crusts must be thoroughly removed* and the lids cleansed. This should be done by means of warm water. To the water bicarbonate of soda (baking soda) may be added, as much as can be lifted on a sixpence to an ordinary tea-cupful of water. When the lids are perfectly clean they should be smeared with ointment of the yellow precipitate.[1] This must be kept up till the lids are quite restored, for the inflammation very readily returns. If the inflammation is very far advanced, the lids thickened and raw looking, &c., after crusts have been thoroughly removed the edges of the lids may be *lightly* touched all along by a stick of nitrate of silver. In such cases it is also necessary to pull out the hairs seriously affected. As this affection is apt to spread among badly-nourished children, and children not in vigorous health, good diet should be given, and exercise in the fresh air attended to. Cod-liver oil is of great benefit also.

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[1] Yellow oxide of mercury (precipitated) 20 grains to 1 ounce of lard or vaseline.

The inflammation can apparently be conveyed to sound eyes by particles of the crusts or matter. Care must therefore be taken that towels, &c., used by the sufferer are not used by others, and that hands are well washed after bathing the eyes, &c.

Turning outwards or inwards of the eyelid is frequently a result of the above inflammation. The former is properly called **ectropion**, the latter **entropion**. Injuries, burns, &c., are causes, and the inward turning is frequent as a result of the general laxness of the lid in aged people. The inturned lid grievously irritates the eyeball, against which the lashes rub, and leads to serious inflammation. In the case of the out-turned lid, the inner surface looks red and fleshy from the constant irritation of the air, dust, &c.; and the eyeball, being deprived of the protective covering of the lid, is also open to irritation by foreign particles, &c. Both conditions can be properly remedied only by surgical operation. The operation is not at all serious or dangerous.

Stye (*Hordeolum*) is a small boil formed on the edge of the eyelid, occupying the sac of an eyelash. Several are apt to occur one after the other, probably because a bad state of health determines them. They form little red swellings, accompanied by considerable heat and pain. When matter has formed, the pain usually ceases. The stye begins usually with an itchiness, producing a tendency to rub the part.

Treatment.—At the very beginning, before the swelling has formed completely, pulling out the lash which passes through the affected part, and then touching the place with a fine point of nitrate of silver, is said to stop its further progress. When, however, it is advanced, warm poultices should be applied, and as soon as matter is formed it should be permitted to escape by opening with a sharp clean lancet. A strong needle will do if it is put in at one side of the little collection of matter and made to open it up to the other side. A mere prick is not sufficient, since it does not afford room enough for the complete escape of the matter.

If a person is troubled with frequent styes, cod-liver oil, iron tonics, good food, &c., are means of strengthening the person to prevent them.

Tumour of the Eyelid (*Chalazion*) is formed in the depth of the lid. It is sometimes due to the blocking of the channel of one of the glands of the lid, and the gland consequently becomes filled and swollen out by its products having no outlet. The swelling is usually round, pea-like, and often very hard.

Treatment.—When the swelling is softish, warm applications, and rubbing in of the yellow ointment (see foot-note on p. 475), are sometimes sufficient to clear it away. When it is hard, the best thing is to have it cut out—a very simple and not a very painful proceeding.

Inflammation of the Inner Surface of the eyelids (*Cold-in-the-Eye—Conjunctivitis—Ophthalmia*).—This is the common form of inflammation of the eyes resulting from cold. The delicate mucous membrane which lines the inner surface of the lids is called the conjunctiva. As stated on p. 447 it not only lines the lids but turns up on to the eyeball, which it covers up to the edge of the transparent part in front—the cornea. Consequently this inflammation affects not only the lids, but also the surface of the eyeball, with the exception of the cornea.

Its **cause** is usually cold, but irritating vapours, the entrance into the eye of irritating substances, will also produce it. It happens in the course of some fevers, specially scarlet fever and measles.

Symptoms.—In its simplest form there is redness of the lining membrane, and if the eyelids be examined they present a red velvety appearance. The person feels smarting and heat, beginning generally at the inner corner; the eye is sensitive and watery, and there is a feeling as of sand in it. The person can scarcely keep from winking and rubbing, and believes some sand is in his eye, the removal of which will be sufficient. In more severe cases the redness is more decided; the blood-vessels are seen to be very full and distinct; the lids are swollen, and the loose tissue between the lid and the eyeball is swollen. There is discharge, of a clear sticky character, consisting of mucus, which forms a sort of film, and blurs the sight. The discharge dries and forms crusts along the edge of the lids. In the morning the lids are usually glued together with it. These are the symptoms of **catarrhal conjunctivitis**. In still more advanced cases the discharge is profuse and of yellow matter (pus), and we have **purulent conjunctivitis**. The swelling is very great, sometimes so as to overlap the eyeball. This is very serious, and must be carefully attended to lest pustules and ulcers form.

Treatment.—First of all, one must look to see that there is nothing present under the eyelids keeping up irritation and so causing the redness. Incurved hairs will do this, particles of dust, and little white gritty particles that form in the substance of the membrane, are often the cause. If such causes be removed, in simple cases a mild lotion with which to bathe the eye is sufficient. The chamomile-tea or sulphate of zinc eye-wash is best suited for this purpose (APPENDIX OF PRESCRIPTIONS—EYE-WASHES). Let the person give the eyes rest, and freedom from glare of gas-light, &c., for a time. The irritation of tobacco smoke should also be avoided. In the catarrhal form similar treatment is required. The person should bathe the eyes with the lotion so that it may enter the eyes and come into contact with the whole surface. A stronger wash—the bichloride of mercury wash—is sometimes required. (See APPENDIX.) When the smarting and swelling are considerable, great relief will be experienced by taking a pad of lint or muslin, soaking it in the last-named lotion, to which hot water has been added, and binding it on the eye. The purulent form is so apt to produce serious damage to the front of the eyeball, injuring the sight, that the sufferer will display wisdom by seeking at once the advice of a competent surgeon. If that is not at the time possible, the treatment recommended above should be adopted and kept constantly in use, every particle of matter being removed as soon as formed. It is not sufficient simply to bathe the eyes on the outside, the lids must be opened so that the removal of matter, that would otherwise lodge, is secured.

Inflammation of the Eyes of newly-born Children is considered under DISEASES OF CHILDREN.

Pustules, the size of a pin's head or millet-seed, are often found in the eyes of ill-nourished children. Usually they are on the edge of the cornea, the transparent part of the eyeball, and look like little raised ulcers. They are called in medical language **phlyctenæ**. Sometimes they surround the edge of the cornea like beads. The lining membrane of the eyeball in their neighbourhood is deeply inflamed, and there is usually considerable pain.

Treatment consists in inserting a piece of yellow ointment (see note at p. 475) into the eye and rubbing it over the pustule by a movement of the lids. To get the ointment into the eye, take it on the end of a smooth piece of wood, say the thickness of a match; gently turn out the lower lid and smear it on, then rub the lid over the eyeball. The person's general health ought also to be attended to.

Thickening of the Lining of the Lids (*Granular Lids—Egyptian Ophthalmia—Trachoma*).—After prolonged inflammation of the eyelids their inner lining becomes studded by shaggy little elevations, which appear like sago grains, and make the surface very rough. The irritation maintained by the rough lids, as they move over the eyeball, encourages inflammation. The transparent cornea becomes affected, blood-vessels are formed over it, and in the end it becomes so thickened and covered with vessels that the person cannot see with the affected eye. The eye is extremely sensitive to light, and scalding tears are constantly flowing from it.

The **treatment** is of considerable difficulty. The inner surface of the lids should be scarified to destroy the elevations, and then glycerine of tannin should be dropped on the lids, which should be taken between the fingers and vigorously rubbed together. Only a surgeon can do this properly. All the patient can do is to keep the eyes clean and use one of the washes already noted.

Burns of the inner surface of the eyelids, that is of the conjunctiva, should be treated by dropping into the eye a little castor-oil in each ounce of which 2 grains of sulphate of atropia have been dissolved. When the burn is deep, the danger is of the inner surface of the lid becoming attached to the surface of the eyeball in the process of healing. In this way the lid may become so attached to the eye as to cover up the ball and prevent sight, and at the same time bind the eyeball and prevent it being moved about to any extent. This condition is called **symblepharon**. Sometimes, as the result of burns, the margins of the two lids grow together. This is called **anchyloblepharon**.

An operation is required to remedy either condition.

Foreign Bodies within the eyelids.—Everyone knows the annoyance and pain caused by getting something into the eye which has no business there, and which is consequently called a "foreign body." Everyone should be able to look for and turn out such an intruder. First cause the person to open his eye as wide as possible, and turn his eye up as far as possible. Let a finger be placed on the outside of the lower lid to pull it slightly downwards. By this means the lower lid is turned out and the searcher can see if anything is there. If the person turns the eye to one side and another, when directed, the whole surface is readily examined. If any particle is seen it is readily removed by the corner of a soft cloth. If a camel-hair pencil is at hand it is the best to brush out any particles. Next examine the upper lid, which also must be turned out, though that is not so easily done. The person having turned his eye downwards, catch hold of the edge of the lid by the eyelashes, and pull it well downwards and forwards. Put the point of one finger on the top of the lid, well under the eyebrow, and turn the lid over on to it. A little practice makes this very easy, but at first it is difficult. If the searcher cannot do this, then let him turn the lid over on the point of a pencil or on the wrong end of a match, &c. If the foreign body is on the lid, remove it as already advised. Foreign bodies on the eyeball are spoken of on p. 481. In every case of prolonged irritation of the eyelids a foreign body should be looked for.

Drooping of the Eyelid (*Ptosis*) is a paralysis of the muscle that lifts the lid, which, therefore, hangs over the eye and prevents it seeing properly. Children are sometimes born with it. It is sometimes due to affections of the brain. In cases where children are born with the droop, a small operation may be performed for shortening the lid and preventing it overlapping the sight too much.

Inability to shut the eyelid is caused by paralysis of the nerve supplying the lids—the seventh nerve (see p. 152). It is usually accompanied by other signs of paralysis of the face (p. 177).

The **treatment** for the paralysis cannot be discussed here. When, however, the inability to close the lid threatens danger to the eye, by dust, &c., readily falling upon it, and by drying through exposure, it becomes necessary to stitch the two lids together for a part of their extent, in order to afford some protection to the eyeball.

Twitching of the eyelids may be a mere peculiarity of an individual, or a sign of St. Vitus' dance (p. 182).

Bruises of Eyelids lead to a black eye. The disfigurement resulting may be partly prevented, and at least the discoloration made to disappear more quickly, by the following method. *Immediately after* receiving the injury, if possible, apply cold-water cloths all over the eyelids, and keep renewing them for some time, from a quarter to half an hour. The object of this is to prevent bleeding taking place into the substance of the lids and surrounding parts from small vessels that have been burst; for it is this bleeding that produces the swelling and colour. *After an hour or two* has passed since the injury, apply warm cloths, not too warm, and keep bathing with warm water as long as one's patience will permit. Before going to bed a thick pad of flannel, wrung out of warm water, should be bound over the injured part. The warm applications should be kept up till the swelling and discoloration have disappeared. All rubbing with lotions, arnica liniments, &c., should be abstained from. They do more harm than good; and, on a part badly bruised, are apt to lead to suppuration or sloughing. The hot applications are sufficiently stimulating and promote the removal of the effused blood, &c. *The most utterly wrong thing to do* is to apply leeches or lancet. These draw fresh blood from the vessels, never remove from the part blood already poured out. They make opening for the admission of air, and are invitations to suppuration and death of the part.

Wounds of the eyelids should be treated by a surgeon, since he may so adjust gaping parts as to leave little permanent mark. This is best done in appropriate cases by stitches.

DISEASES OF THE TEAR APPARATUS.

Obstruction of the Tear Passage.—On p. 447 the nature of the apparatus for carrying off the tears has been described. The canals in the inner portions of the lids are narrow, and the opening on the edge of the lid small. They are, therefore, very easily blocked. A swollen condition of the lining membrane is quite a sufficient cause of such a blocking; and, since the lining membrane is continuous upwards with that covering the inner surface of the eyelid and part of the eyeball, and downwards with that lining the nostrils and throat, it is liable to share in affections of these other parts. Cold-in-the-head, for this reason, readily extends up the tear passages, producing swelling and increased amount of secretion from the membrane. The obstruction very often begins, not in the canals, but in the tear-sac (p. 447), which becomes affected by the catarrhal condition (p. 214).

Symptoms.—The person is troubled with "a weeping eye." The tears gather at the inner corner of the eyelids and run down over the cheek. Especially is this troublesome in cold and windy weather. The nostril of the affected side is dry. Sometimes, owing to accumulation of discharge in the sac, a small swelling is formed at the inner angle of the eyelids. If the person press with his finger over the swelling it may be emptied, discharge welling up through the tear passage into the eye. The discharge may be clear or mattery. But if the sac cannot be thus emptied the matter is apt to burst its way through the skin at the side of the nose, and a small opening is produced through which matter comes. This is a **fistula** of the tear-sac. *Acute* attacks of inflammation are not uncommon. The inner part of the eyelids becomes red, dry, swollen, and acutely painful, and the inflammation may extend along both lids, so that the eye becomes almost or quite closed.

Treatment is most successful if begun early. Everyone with a "weeping eye" should at once seek competent advice, lest this affection be present. A probe is passed along the canal and down through the sac into the nostril. When this is carefully done it is not so painful as would be expected. It clears the passage and restores the use of the part. But it must be done frequently, till the passage is made quite clear and remains so. Hot applications are the appropriate remedy in acute cases, the probing being delayed till the acute attack has passed.

DISEASES OF THE EYEBALL.

The cornea or transparent window of the eyeball is most liable to disease, to inflammation, &c. It is plain how serious such affections may be. For, if they involve the cornea to any extent, seeing is at once interfered with, and sight may be practically lost, because this part has lost its transparence, and cannot, therefore, be seen through, while every other part of the eye may be healthy. It is, therefore, necessary that people should be able to learn for themselves whenever this part is threatened, and how, in the event of surgical advice being unobtainable, they may avert the danger.

Inflammation of the Cornea (*Keratitis*) may affect only the surface of the part, and be a comparatively simple affection; or it may involve the whole thickness of the cornea, and not pass off till it has rendered it untransparent and cloudy and whitish, with permanently lessened sight.

Its **symptoms** are chiefly extreme sensitiveness to light, pain, excessive production of tears, and sneezing when the eyes are opened. The person usually keeps the eye shut, because of the pain light produces. The eye is running with tears, which scald the lids and face. The pain shoots to the temple and eyebrows. Sneezing whenever one attempts to open the eye is due to the action of the cold air on the irritable eye. So tightly does the person keep the eye shut that it is difficult to get a sight of the ball. If one succeeds in seeing it, a red circle of vessels may be noticed all round the margin of the cornea; and perhaps, by allowing the light to fall sideways on the cornea, one may be able to see that the surface is not so smooth as is natural but appears ruffled. The other symptoms are so characteristic that they are frequently sufficient to indicate the disease though the eye cannot readily be seen.

Treatment.—No lotion capable of irritating ought in such cases to be employed. Specially are washes of sugar of lead to be guarded against, since the lead tends to deposit in the inflamed cornea and leave scars that cannot afterwards be removed. Soothing applications only should be employed. Warm cloths applied to the eye are a great relief. A solution of atropine, 2 grains to the ounce of water, should be obtained, and a few drops dropped into the eye once a day. The eye should be closed and a pad of lint secured by a bandage placed over it. A blister the size of a shilling ought to be placed on the temple, where it is left for twenty-four hours, then removed, and the part covered with a piece of lint anointed with oil or fresh butter. The bowels of the person should be kept regular, and good food ordered. Change of air is beneficial. With such treatment recovery should occur in a week or two. It may be mentioned that an inflammation like this may be maintained by the irritation of bad teeth. The teeth should, therefore, be examined and bad stumps extracted.

In the **severer form** of the attack the central part of the cornea is seen to be roughened and cloudy, and the cloudiness spreads over the whole transparent surface, giving it a ground-glass appearance. It is very serious, since it may only pass off to leave the cornea so white that sight is seriously diminished if not lost. The cornea, which in health possesses no blood-vessels, is also liable to become invaded by vessels, which render recovery still more difficult. The inflammation may run on for weeks and months, attacking one eye after the other.

Treatment.—It is specially in children of a very weakly sort that the inflammation is so severe. At its very outset, therefore, attention should be given to the child's health. Cleanliness, good food, fresh air, and cod-liver oil are valuable aids in the treatment. The eye itself is to be treated as directed above. Drops of atropine are to be employed daily; an occasional blister is to be put on the temple; some extract of belladonna is to be made into a moderately thick paint with water or glycerine and spread with a brush over the outside of the shut eyelids, which are then covered with lint, a bandage securing all. Each day the belladonna paint put on the day before is to be bathed off, and more applied. With care this combined treatment will usually be sufficient; but use of the eye is not to be permitted till it is perfectly recovered, and till no trace of over-sensitiveness to light remains.

Abscess and Ulcer of the Cornea are usually the result of injury to the eye—a stroke from a piece of coal, for example; or they occur in persons in depressed states of health. They have the appearance of white spots in the clear part of the eye. In the case of the ulcer, by looking carefully from the side one may see that part of the substance of the cornea has been destroyed, and that there is a little hollow on the surface. When the abscess passes deeply into the substance it may open into the anterior chamber of the eye (p. 448), into which matter drops and in which it collects. When this has happened, if the person is made to look up, the yellow matter is seen at the lower border of the transparent part. Sometimes an abscess or ulcer spreads over a large part of the cornea, so destroying it that a large part of it breaks down and separates. In cases where an ulcer has eaten its way through the whole depth of the cornea, it is not uncommon for the coloured part of the eye—the iris—to be pushed forwards and a part of it to bulge through the opening and appear as a little roundish bleb. This is called **hernia of the iris.** When it occurs it seriously delays recovery and injures the chances of a seeing eye being left. After healing and closing of the ulcer the iris remains caught in the scar, and thus the curtain of the eye becomes attached to the transparent cornea in front. Eye surgeons call this condition **anterior synechia.**

The **symptoms** of abscess and ulcer are intense pain, redness and watering of the eye, and on opening the lids the changes going on are quite apparent.

Treatment.—Apply warm cloths. Carefully abstain from using any irritating wash whatever, such as sulphate of zinc wash or sugar of lead wash, &c. Let fall daily into the eye one or two drops of the solution of atropine (2 grains to the ounce). At night paint over the eyelids with belladonna, as directed on p. 479, and let the paint be bathed off in the morning and warm cloths again used. An occasional blister on the temple will help to relieve pain. The person ought to be well nourished, and if in weak health ought to have quinine and iron tonics, cod-liver oil, or syrup iodide of iron (from half to one tea-spoonful, according to age). If matter appears inside the eye, an operation must be performed for getting rid of it. Abscesses and ulcers are, however, so serious that from the first a competent surgeon should be consulted.

White spots, opacities, on the clear part of the eyeball, are frequently left as marks of inflammation, abscess, or ulcer. Parents often notice that their children suffer from "weak eyes," as they say—that is, the eyes are red, and watery, and the child avoids the light; but they think nothing of it till they observe "a scum growing over the sight." This simply means that inflammation has been permitted to go on neglected, and the part has lost its transparency and become cloudy. In children something can sometimes be done to diminish the white cloud, but it is not often it can be made entirely to disappear. In grown-up persons these white spots cannot be removed at all. Many people are also under the delusion that the whiteness is caused by something that has "grown over the sight," and can be cut or scraped off. This is a mistake. It is no new thing added to the front of the eyeball, it is simply a part of the cornea that has become white owing to inflammation. If these opacities, as they are called, are to be avoided, it is by having each eye carefully attended to as soon as there is the least evidence of anything wrong.

Treatment.—Bathe the eye with an infusion of chamomile flowers, weakened by the addition of warm water. When the white cloud prevents sight, the eye can frequently be improved by an operation for forming an **artificial pupil**, called **iridectomy**, which consists in making an opening in the cornea, passing in a fine forceps, seizing and pulling out a part of the curtain of the eye—the iris—and snipping it off with scissors. An oval opening is thus made in the iris, through which light can pass. This is very successful in restoring sight when the opacity occupies the centre of the cornea, leaving a broad clear margin, and when the eye is otherwise healthy. The result of the operation is simply to make a new pupil; and of course the place which affords the most room for this is selected, provided it is in such a position as to be quite uncovered by the lids when the eye is open. Another case also very favourable for the operation is where the opacity is largely one-sided, leaving the other side clear. But when the whiteness extends over nearly the whole of the cornea, no operation is likely to do much good.

Staphyloma is the proper term applied to the condition shown in Fig. 197. As a result of inflammation the cornea becomes cloudy and weakened, and yields before the pressure within. The bulging is often so great that the eyelids cannot close over it. It is very disfiguring, and sometimes it is best to have the eyeball entirely removed. Its presence often is a source of weakness to the sound eye, and on that account its removal is still more desirable.

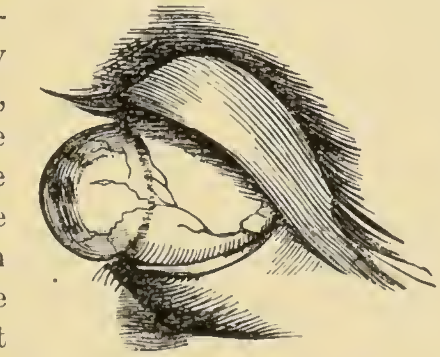


Fig. 197.—Staphyloma of Eyeball.

Foreign bodies in the cornea are very common among miners, iron-workers, and people of similar employment. *Fire in the eye* is the usual phrase they have for such things. If the foreign body is loose within the eyelids, it is to be removed in the manner described on p. 478. But frequently small particles stick in the substance of the cornea, and require removal by means of some sharp instrument. In every large work there is usually one man specially skilful in removing such bodies, but frequently the most some of them succeed in doing is to scratch the cornea in various directions and set up serious inflammation. No one should attempt to remove such a body except with the clearest light. Often when the most careful examination in the ordinary way fails to reveal anything on the eyeball, the use of a large hand-lens to focus the light on to the cornea will show the speck. Specially if the person look sideways over the surface will he see the presence of any irregularity of the surface. Eye surgeons have special lance-pointed needles, set in handles, for removing foreign bodies. The patient sits facing a window, and his head is to be firmly held by someone behind. The operator sits directly opposite the patient, and opens the eye with the forefinger and thumb of the left hand, fixing the eyeball by slight pressure with finger and thumb. *He must never scrape at random*, but cause the patient's head to turn, or cause him to turn his eye, so that the light falls in such a way as distinctly to show the foreign body. The needle is now to be deliberately and carefully placed down at the side of the body, and moved so as to turn it out; and this repeated till the object is removed from its fixed position, when the lid moved over the place by the finger may finally remove it. No sudden scratches must be made, one after the other, in the hope that one of them will effect the desired purpose. If good daylight cannot be obtained the person should be set down at the side of a gas bracket, which can be moved to cast the light on the eye in the way best fitted to show the foreign body, and a hand lens used to throw a strong beam of light.

Wounds of the Cornea are frequent from chips of steel, pieces of coal, &c. Pieces of coal are the worst, from their dirtiness. It is of the utmost consequence in such cases to know whether the chip that struck the eye has passed into the ball, or has simply cut the cornea. This is generally made out by shutting the eye and pressing gently but firmly all over the upper and lower lid. If pressure at a particular spot causes a sharp pain each time it is made, the chances are the piece that has struck the eye has passed inwards. If this is so, the eye almost surely will require removal, and that speedily, lest the sound eye becomes inflamed by sympathy (p. 485). Another danger of wounds of the cornea is that, if the cornea is completely cut through, the curtain of the eye—iris—may bulge forward into the wound. This not only delays healing, but serious inflammation may arise from the pinching of the iris in the wound. Wounds of the cornea may also lead to abscesses, ulcers, &c.

Treatment.—Till competent advice can be obtained the eye should be carefully bathed with warm water. A drop of solution of atropine (2 grains to the ounce of water) should be inserted within the lids, which must be very carefully and gently opened for the purpose. A pad of lint should then be applied over the eye, and secured by a bandage pressing just sufficiently to prevent movement of the lids. If pain is great, apply hot cloths over the pad. The atropine may be dropped in twice a day. If inflammation of the sound eye threaten, no time must be lost in seeing an eye surgeon, lest both eyes be destroyed.

Inflammation of the white of the eye (the sclerotic, p. 447) appears in the form of a round red swelling, yellowish on the top. It may form a prominence of the size of a pea or small bean. It is to be treated with warm fomentations, and the eye is to be closed, a pad and bandage being applied.

Inflammation of the Iris (*Iritis*).—The iris, as explained on p. 448, is the curtain of the eye, whose hue gives the colour to the eye. In its centre is the round opening or pupil. The iris regulates the amount of light admitted to the eye. By contracting it narrows the pupil to a very small opening; and this it does under the influence of much light. By dilating it widens the pupil, and this it does when light is dim, so that more may be admitted. It is, therefore, easy to test whether the iris is in a healthy condition. Shade the eye from light, the pupil should widen; let the light fall full upon it, the pupil should narrow. This test may also be applied by simply shutting the lid of the person whose eye is being examined and then rapidly opening it. On the instant of opening, the pupil is seen to be wide, and it immediately contracts. In dim light a taper may be used and brought near or held close to the eye.

The chief **symptom** of inflammation is the inability of the iris to act under the influence of various degrees of light, or it acts very slowly. This is due to the curtain becoming thickened by the inflammation. Perhaps the first symptom is intense pain, worse at night, so that the sufferer gets no sleep. Light falling on the eye is painful, and the tears flow. But neither of these symptoms is so bad as in inflammation of the cornea. When the eye is carefully looked at, and compared with the sound eye, it is found to have changed colour, and is of a greenish, reddish, or yellowish hue. Then the action of light should be tested as already explained. On carefully looking at the eye a circle of fine red vessels may be seen surrounding the transparent cornea.

The **causes** of this inflammation are various Rheumatism is a very frequent one and syphilis. In inflammation resulting from syphilis it is common to see one or more red fleshy points on the border of the curtain. Cold may also induce an attack.

The **results** of the disease may be very serious. The iris may become attached to the lens behind so as to become permanently fixed. This is called **posterior synechia.** In some cases the pupil becomes altogether closed, causing loss of sight.

Treatment.—Whether one is sure of the true character of the disease or not, the first thing to be done is to let fall a few drops of the solution of atropine into the eye, and to repeat this once or twice daily. This widens the pupil, so that if it becomes immovable it is fixed in the most favourable position for sight. If the case is advanced the pupil may not widen at all. This is a sure indication of the nature of the disease. Keeping the pupil wide also keeps it at rest and aids recovery. The eye should also be closed, the belladona paint (p. 480) applied, as well as a piece of lint and a bandage.

The patient should secure a free movement of the bowels by one or two of the compound blue and colocynth pills. This may be repeated every second night for several times. In severe cases a pill containing 2 grains of blue pill and 1 grain of quinine (for grown-up persons) may be given twice or thrice daily for a week or ten days, unless the gums become sore, when they should be stopped. A blister on the temple aids the purgative medicine in relieving the pain.

When the disease has passed off it may leave a very contracted or closed pupil. After a sufficient time has elapsed—several months—an operation may be performed for the purpose of making an artificial pupil and restoring some degree of sight by affording a passage for rays of light. The operation is called **iridectomy** (see p. 481).

Cataract is an affection of the crystalline lens (p. 448), by which it gradually ceases to be transparent and becomes more and more opaque. There is no mistaking a case of ordinary cataract. The window of the eye is quite clear, the iris has its usual appearance, but through the pupil is seen the whitish lens. It was called cataract by the ancients from the Greek verb "to flow down", because of the idea that the dimness of sight was due to some watery material flowing down behind the pupil and obscuring the sight. It is caused by some alteration in or interference with the nourishment of the lens. It is commonest in old people from the general failure due to age, a large number of cases being in persons over forty years of age, and the largest number in persons over sixty. In diabetes (p. 407), a disease profoundly affecting the nourishment of the body, it is very common. It is also caused by interference with the lens through accident. Any injury of the eye, which has affected the lens, is likely speedily to lead to cataract. Children are sometimes born with cataract. In some of these cases the opacity extends over the whole lens, in others it is confined to a small part of the lens, and appears as a white spot beyond the dark pupil.

Cataract usually, in cases of old persons, comes on slowly, so that the person feels a gradually increasing dimness of sight, which spectacles do not benefit. There is no pain, and the loss of sight never occurs suddenly. But as dimness of sight may arise from many causes, only an examination of the eye is sufficient to decide whether cataract or other disease is the cause. When the cataract is complete, that is when the entire lens is quite opaque, so that for all practical purposes the person is blind, the light from a lamp or candle can still be perceived in all directions, and the person can point to its direction if it is moved about.

Treatment.—In favourable cases, that is in cases where there is no other disease that would interfere with sight though there were no cataract, the opaque lens can be removed by an operation, and good sight restored. Of course, after the lens has been removed, strong convex glasses must be used to enable the person to read. The favourable cases are known by the person being able to follow the light from a lamp moved in all directions, and to point to its direction. This operation consists in cutting round the margin of the cornea until a sufficient opening is made for the lens to pass through. An instrument is passed through the opening to tear open the capsule which holds the lens. When this has been properly done, gentle pressure of the lids urges the lens out. Immediately after the operation the patient should be able to see clearly with the eye. A person desiring this operation to be performed should always place himself or herself in the hands of an eye surgeon of repute, since there are a considerable number of risks (to the eye only) that attend the operation. For example, if undue pressure be exerted on the eyeball, not the lens only, but some of the vitreous humour behind it, may be pressed out. If much of this escapes, the sight of the eye will be lost. The operation, therefore, requires skill and delicacy. As soon as the lens has been removed the eye is closed with plaster and a bandage, and the patient is put to bed and kept lying quietly on the back in a dark room for several days. If all goes well the bandage is not undone for four or six days, and it is at least a week before the person is permitted to get up, and several weeks before he is permitted to begin gradually to accustom the eye to light.

An old operation, called **couching**, consisted in passing in a needle and with it pushing the lens out of its place to leave the pupil clear. The lens thus was left in the eye; but it was so apt to set up inflammation by its presence in an unusual position that this operation has been abandoned.

For this operation chloroform is not at all necessary. Indeed surgeons prefer not to give it if the patients are old enough to keep still.

In children the lens is soft, and cataract, when complete, is dealt with in them by passing a needle through the cornea, and through the capsule of the lens, and stirring up some of the soft lens so that it escapes into the chamber behind the cornea—the anterior chamber of the eye (p. 448). It is gradually absorbed there, and after some weeks, when all evidence of the operation has disappeared, the process is repeated with another portion of the lens. In about three months, by repeated operations, the lens disappears, and sight is restored.

Diseases of the Retina (p. 449), **Choroid Coat, and Optic Nerve** are numerous, and are the causes of serious defects of vision and of blindness. It is useless to consider them in this work, since their detection requires an oculist. Some features regarding them may be mentioned. Very serious disease may exist in the deep parts, and at the back of the eye, without any evident symptom. The sufferer is aware of something wrong from failing sight, which he in vain strives to benefit by spectacles.

Inflammation of the retina (*retinitis*), inflammation of the choroid coat (*choroiditis*), inflammation (*neuritis*) and atrophy (*wasting*) of the optic nerve are the names of some of these affections. They arise from many varied causes. Exposure to cold, changes in the blood such as exist in anæmia and in syphilis, diseases of the brain, and many other causes operate in producing such affections. It is of the utmost importance to observe that excess in spirituous liquors and in tobacco not infrequently leads to failure of sight from changes in the nervous structures of the eye. For such cases total abstinence is the only treatment. In women too prolonged nursing may produce weak sight from affection of the retina and optic nerve.

Separation of the Retina (*Dropsy of the Retina*).—In this disease fluid is poured out between the retina and choroid coat at the back of the eyeball (p. 449), with the result of partly separating them from one another. The retina is caused to bulge forwards, at least that part of it behind which the fluid is. Blindness more or less complete, according to the extent of the separation, results.

Treatment of various kinds has been tried with indifferent success. Complete rest in the horizontal position for some weeks, the use of warm packs to promote sweating, a calomel and jalap purge twice a week, and light diet are the lines of treatment to be followed immediately the detachment is recognized. In some cases an oculist may deem an operation worth trying.

Glaucoma is the name given to a disease which affects every part of the eyeball and ends in complete blindness. The chief feature of it is that the eyeball becomes of a stony hardness. It sometimes comes on quickly in an acute form, sometimes it creeps on slowly. The disease occurs in old and weak persons, sometimes from exposure to cold, sometimes apparently from fright, and from other causes.

The **symptoms** of the acute attack are violent neuralgic pains in the eyeball, brow, and temple, and perhaps vomiting. Dimness of sight comes on rapidly. The patient sees rays of colour round the flame of a lamp, candle, or gaslight. The eyeball, as already mentioned, becomes very hard. In chronic cases there are only occasional attacks of neuralgic pain, and the eyeball gradually becomes of a stony hardness. In time other changes occur in the cornea, lens, &c. In advanced cases the pupil has a greenish look; hence the name *glaucoma*, which means green tumour.

The treatment commonly adopted is the performance of the operation of iridectomy, noted on p. 481. It was first suggested by the distinguished German oculist, Von Graefe.

The **ophthalmoscope** is the instrument by means of which the deep parts of the eye can be examined, and the condition of the nervous coat at the back ascertained. It consists of a small mirror on a handle. The mirror is slightly concave (hollowed). It is held in front of the eye of the examiner, and in its centre is a small hole through which he looks. The patient sits opposite the examiner. Behind his head and to the side is a lamp producing a bright light. The examiner catches the light on the mirror and throws it through the pupil of the eye he is looking at through the small hole in the mirror. The back of the eyeball is illuminated just as one might illuminate a room by throwing a strong beam of light from a bull's-eye lantern through an opening in one wall. The use of the instrument requires practice; for unless the examiner's head is in the direction of the light reflected from the eye, the pupil will appear black and he will see nothing. As soon as he catches the light coming back from the eye, he sees a red glow from the back of the eye, and by gradually bringing his eye, with the mirror in front, nearer, he at last reaches the position from which he sees the opposite wall of the eyeball. The optic nerve entrance, the blood-vessels passing over the retina, &c., are seen, the condition of the humours of the eye is perceived, and one familiar with the healthy appearance can make out change from disease. The instrument was devised by the late Professor von Helmholtz of Berlin. The mirror may be used alone, or with a doubly convex lens.

Foreign bodies within the Eyeball are unfortunately very common among workers in coal, iron, steel, &c. Striking with sufficient force, the chip of steel, &c., pierces the coats of the eyeball and passes to the inside. The piece may lodge in the iris, from which it may sometimes be removed with the wounded part of the iris by the operation of iridectomy (p. 481). If it lodge in the lens this body speedily loses its transparency, and may be removed with the foreign body by the operation for cataract. It may lodge in the back chamber among the vitreous humour, or in other situations from which it cannot be removed. Sometimes it may be seen by means of the ophthalmoscope and removed by a magnet. In many cases the person is not sure whether the foreign body that struck him passed in or simply wounded the eye in flying past. In such cases, if pressing over the eyelids in one particular spot produces a sudden sharp pain, the probability is the body is within the ball. Inflammation arises, severe pain is felt, the sight grows dim, &c. The danger is of **sympathetic ophthalmia** arising. This is inflammation occurring in the sound eye through nervous communication with the injured one. It is extremely serious. If the slightest sign of it arise, the injured eye should be removed without delay, even though it be yet a seeing eye, in order to save its fellow.

Rolling Eyeballs (*Nystagmus*).—This is a continuous rolling movement of the eyeballs, which are constantly shifting about. It is seen in children the corneæ of whose eyes have lost all their transparency owing to inflammation, and perhaps is due to their seeing the light and continually endeavouring to gain clearer vision. Various other diseases of the eyes affecting vision produce it. Among miners cases of it arise by no means seldom. In them it appears to be induced by long-continued work underground in the dim obscurity of a flickering lamp. It gradually becomes associated with nervous disease of the eyeball. Little can be done for it. But a young lad who has already worked some years underground, and shows signs of it, should at once be persuaded to change his occupation and take to something above-ground in the ordinary light.

Squint (*Cross-Eyes—Strabismus*) has been mentioned on p. 455. It is usually due to one muscle having a greater pull than another, so that the balance between them is lost. It may, however, result from paralysis of one muscle, by a blow, for example, the opposite muscle thereby gaining the advantage. There are several kinds of squint, the two chief being inward or convergent, and outward or divergent. It has been shown that inward squint, in a large majority of cases, is dependent on long-sightedness, and outward squint on short-sightedness. Outward squint, however, is not so common as the other variety. Of convergent or inward squint Stellwag, one of the greatest of authorities on eye affections, says it "is frequently developed at a very early age in children, whose attention is often and continually attracted to small objects situated near the eyes, to whom picture-books and similar playthings are offered for amusement, which demand clear and distinct vision at short distances. As a rule, however, inward squint first makes its appearance at the commencement period when children go to school, when children are compelled for hours to read, write, and engage in similar occupations. . . .

"Everything that increases the necessity for focussing also increases the tendency to squint. In so far insufficient illumination, dark rooms, bad care of the child during the occupation, &c., may favour an occurrence of the strabismus."

Now when squint exists, whether in one eye or both, the two eyes cease to act in harmony, and one of the chief benefits of seeing with two eyes—binocular vision (p. 458)—no longer exists. Moreover, supposing one eye only to squint, it invariably happens that the sight of that eye is largely discounted, is disregarded. Were that not so, seeing that the two eyes do not agree, objects would appear double, but by disregarding the sight of the squinting eye single vision is retained. The result of continued disregard, however, is that the squinting eye loses its sharpness of sight, its vision becomes blunted. Anyone may learn this for himself by causing a person with a squinting eye to look at an object first with one eye and then with the other, and he will find how dulled the squinting eye has become.

The **treatment** for squint is twofold. In the first place, with children the causes leading to squinting must be done away with. They should not be required to look long at objects so small as to require much focussing of the eyes; their reading, writing, &c., should be taught in well-lighted rooms. If the child is quite young when the tendency shows itself it will be well to cease instruction of such kinds, of knitting, &c., for a time. When the child is old enough, glasses to correct the long sight should be obtained. It is also a good thing, when there is but one squinting eye, to have the sound eye closed up by means of a bandage for fifteen minutes several times each day, in order to compel the use of the erring one. Of course such procedure is useless unless the other steps already described have been taken. Should these measures fail, an eye surgeon would probably propose an operation. It consists in cutting the muscle of the side to which the eye is pulled. It is a simple operation, not requiring chloroform in grown-up persons. It is desirable to do it early, if it is certain other measures fail, before the eye has been blunted from disuse. The muscle is, by the operation, detached from its position. It slips backwards for a little distance, and in course of time attaches itself to a new part of the eyeball. In effect the muscle is lengthened, so that it no longer has the pull over its fellow on the opposite side. Even when this has been done, providing spectacles to correct any long or short sight that may be present ought not to be neglected. In grown-up persons its main benefit is the correction of an unpleasant feature. To girls this is always of moment.

AFFECTIONS OF THE SENSE OF SIGHT.

Short-sight (*Myopia*) and **Long-sight** (*Hypermetropia*) have been explained on pp. 454 and 455. For the former the treatment is doubly concave spectacles, for the latter doubly convex spectacles, which any optician can supply. Care should be taken *never to get concave spectacles too strong,* else the short-sighted eye is converted into a long-sighted one. Persons cannot suffer from any degree of short-sight without being aware of it. They cannot recognize a friend at any distance, nor read a sign over a shop door on the opposite side of the street from them. But long-sighted persons see well at a distance. If they are only slightly long-sighted it is only when they come to look at near objects that the defect occurs. But when the error is slight, persons may not be aware of the long-sight, so effectually does the focussing serve their purpose. But they are continually focussing to see objects which ordinary eyes perceive without any alteration of the lens; thus their apparatus for accommodation of the eye (p. 453) is continually in use and becomes strained. The person may go on for years unaware of this. By and by, however, the person begins to feel an undue strain on his eyes with reading, writing, drawing, &c. His eyes ache with any prolonged use. They look red and watery after work. After reading for a time the letters run together. He shuts his eyes for a moment, and then on opening them he can read a little time longer, till the letters again run together, and so on. It is easily seen, therefore, how giving a short-sighted person too strong glasses, and converting him by them into a long-sighted individual, makes matters worse.

A short-sighted person is likely to improve as age advances. The lens becomes flattened, does not converge the rays of light so strongly, and therefore the degree of short-sight diminishes. As years pass, weaker glasses often suffice.

Weak Sight (*Asthenopia*) is as often due to a slight degree of long-sight as to anything else, and the remedy for this should be tried.

Defective Sight from Age (*Presbyopia*—Greek, *presbus*, an old man). With advancing years the lens loses its elasticity, and consequently its degree of convexity undergoes less change than in youth. It also becomes flatter. Near objects are not so readily focussed. As age grows, persons find themselves less and less able to read and do fine work with the unaided eye. Happily convex spectacles readily restore the former distinctness of vision, if nothing else is at fault with the eye.

Astigmatism is a curious defect of the eye, first observed by Thomas Young. It is due to the cornea having different degrees of curvature in different directions. Usually the vertical meridian is more curved than the horizontal. The result is that rays of light passing through the vertical meridian will come to a focus sooner than rays passing through the horizontal meridian. Consequently, all the rays from an object are not brought to the same focus, and the object appears blurred. All eyes have this defect to a slight extent—to such a slight extent that it is not noticed. But let anyone draw a perpendicular line on a black board with chalk, let this line be crossed by another at right angles, and let the person, standing at a distance, look at the point where the two lines cut one another. Looking at this point steadily he will find that he sees both lines, but one more distinctly than the other, showing both are not focussed at the same time. Of course one usually moves the eyes rapidly over objects looked at, and forms the idea of them from successive glances, without being aware that the whole object is not distinctly perceived at one glance. It is only when the defect is excessive that persons become aware of it. The error is corrected by the use of glasses ground from a cylinder; ordinary glasses are ground from a sphere. Such spectacles are plane in one direction and concave or convex in the other. The glass is so placed that the direction of the curve is placed over the meridian of the eye requiring correction, and the degree of the curve is so arranged that by its means the cornea is made practically equally convex in all directions. Short-sight or long-sight is often associated with astigmatism, so that special spectacles require to be made which shall correct the long or short sight and the astigmatism as well. It is often a matter of very considerable difficulty to determine the degree of the defect, and the decision as to the sort of glasses required is often a very tedious process. Astigmatism is very commonly inherited.

Blindness may be due to many causes, loss of transparency of the cornea (p. 480) or lens (p. 482) preventing the entrance of light, diseases of the choroid, retina, or optic nerve (p. 483), affections of the brain, &c.

Amaurosis and Amblyopia are old words, used to express, the former total blindness, and the latter dimness of sight. They were used before the causes of such conditions could be ascertained; but as these conditions are now referred to affections of retina, optic nerve, &c., the old names are being dropped.

Partial Blindness (*Hemiopia*) of an eye, with which nothing seems wrong, may occur. The person, looking straight at someone standing in front of him, sees only one half of him. Half of the retina is blind. This may begin in one eye, but extend to both, the vision of a corresponding half of each retina being lost. It is due to disease of the optic nerve roots. Syphilis is frequently the cause.

Night-blindness (*Hemeralopia*) is the result of a blunting of the sensitiveness of the retina owing to some excessive irritation. It has its origin in the long-continued action of strong light upon the eye, and is also connected with weakness of the nervous system. The retina may be blunted by the strong glare from snow; and this may occur to those who walk over fields of snow or ice among the mountains, without having the eyes protected by a dark veil or dark glasses. This is called **snow-blindness**. Similarly, **moon-blindness** is a like condition, produced among sailors in the tropics who sleep on deck under the full light of the moon.

Colour-blindness (*Daltonism*).—This affection was called *daltonism* because it was first described by John Dalton, in 1794. Colour-blindness, however, exists in several forms. The form to which the term "daltonism" is properly applied is a lack of sensibility to red. Red light and red objects appear greenish or grayish. Since, according to the theory explained on p. 459, the sensation of colour is a mixed sensation, dependent upon the excitement of three sets of nerve fibres, one set sensitive to red, another to green, and a third to violet, an excitement of all three in a definite proportion producing the sensation of white, and in various other proportions the sensations of the other colours,—since this is so, the loss of sensibility to red will affect not only the perception of red but all other perceptions in which the sensibility to red has any great place. Thus the sensation of yellow is due to moderate excitement of the fibres sensitive to red and green, and feeble excitement of the fibres sensitive to violet. Consequently to the person not at all sensitive to red the whole character of the sensation is altered. The fibres sensitive to green are moderately excited, there is no response to the red, and the violet is feebly excited. Thus yellow appears a decided green; red is confounded with brown and green; violet is called blue, and rose-colour is not distinguished from blue.

Besides insensibility to red there is a similar lack of perception of green—**green-blindness**. **Blue-blindness** is another form, in which blue and green, and blue and yellow are confounded.

Red-blindness is the most common. It is inherited, as a rule, and dates from birth, and is commoner in men than women. The best test is to give the person a handful of variously-coloured wools and ask him to place all of one colour together.

In rare cases colour-blindness is complete, and the person recognizes only blacks and whites.

Double Vision is the result of paralysis of some of the muscles of the eyeball. The affected eye cannot be moved round in a particular direction as far as its neighbour; the correspondence between the two eyes is therefore lost, and at that point the object looked at appears double. In other directions of the eyeballs the vision is single. It is the result of tumour or other affection of the brain, such as arises in the course of syphilis. Other causes also may induce it. Accompanying it there are probably other signs of paralysis, droop of the eyelid, dilated pupil, &c., and perhaps some paralysis of the face.

DISEASES AND INJURIES OF THE EAR AND AFFECTIONS OF THE SENSE OF HEARING.

In the first part of this section the division of the organ of hearing into external, middle, and internal ear has been described. All these parts may be attacked by disease, and all are more or less capable of treatment. It is only, however, the diseases affecting the external ear, chiefly the external canal, that can be reached by anyone who has no special knowledge. No disease of the ear, no matter how apparently trifling, should be neglected. An inflammation, beginning in the canal, may pass to the drum, pierce it, and go on to the middle and internal ear, ending in partial or complete deafness. Most cases of acquired deafness are due to such inflammation, which destroys the part of the ear designed for conducting sound, so that though the internal ear may remain healthy, it is deaf because sound cannot reach it.

DISEASES AND INJURIES OF THE EAR.

The Auricle or external appendage of the ear is liable to injuries, to wounds, and bruises. These must be treated as any other wound or bruise in the manner indicated in the section on Accidents and Emergencies. It is also liable to skin affections, specially eczema. The treatment for this is described on p. 425.

Inflammation of the Canal of the Ear—Boils in the Ear Canal. A boil in the ear canal is often caused by irritation from the use of ear-picks or by cold. It is sometimes a sign of a depressed state of health. A general inflammation without the formation of a boil may also arise from similar causes, or attend the progress of measles and scarlet fever, or result from injury.

Symptoms.—There is pain in the ear—ear-ache,—more or less intense according to the degree of inflammation. Movements of the jaw increase the pain as a rule. Hearing is diminished, and noises in the ear are troublesome. On looking into the ear the swelling of the boil may be seen—if it is not too far in—and the skin around it is red. If there is no boil, but a general inflammation, the walls of the canal are reddened and swollen. The canal is also occupied in such a case by discharge, which finds its way to the outside. The ear may go on discharging for a week or two, but if the case becomes chronic it may last for a long time. In the case of a boil, when matter has formed and the boil bursts, great relief is experienced, and the affection, as a rule, speedily passes away.

In the chronic form of the general inflammation there is not much pain, but there is usually some deafness, accompanied by noises in the ear. A constant sense of moisture in the ear is the chief sign, or it may be a continued flow of matter from the ear. The discharge may cease in warm weather, to return again with cold, and so it may continue, if not attended to, even for years. The evil of this is that it leads to thickening of the walls of the canal, and is certain to extend to the drum and the middle ear. It may cause piercing of the drum, and may even continue its way inwards till the membranes of the brain become affected, death resulting.

Treatment.—Warm poultices should be applied over the ear and side of the head. Warm oil or warm glycerine, poured from a spoon into the ear canal, till it is full, is very soothing. Great relief is experienced from the use of olive-oil containing menthol to the extent of 20 per cent. This need not be heated. The canal should be filled with it, and repeatedly refilled, till relief is obtained. If discharge appears, it should be carefully and gently washed out by syringing with warm water containing 15 drops of lysol to the ½ pint. The canal should then be carefully dried as far as possible with cotton-wool, and a piece of dry cotton placed in the passage. When the discharge continues for more than a week, the canal should be syringed with warm water and dried; then half a tea-spoonful of a solution made by dissolving 4 grains of sulphate of zinc in 1 ounce of water should be dropped into the ear, allowed to remain for a few minutes, and then caused to flow out, the canal being afterwards dried and closed with a piece of dry wool. A solution of 2 grains of chloride of zinc to ¼ ounce of glycerine and ¾ ounce of water may be used in the same way. In *each case the solution should be warmed* before being dropped into the ear.

At the beginning of every acute inflammation of the ear a brisk purgative, salts or seidlitz powder, should be given to the patient. In weakly persons good nourishing food and tonics will greatly aid recovery.

Wax in the Ear to excess is a frequent cause of deafness. As we have mentioned on p. 464, wax is produced by glands in the canal, and its presence keeps the walls from being unduly dry. It may be present in excessive quantity either because it accumulates or because it is too freely produced. The irritation of cold, &c., will cause excessive production, but nothing does so more readily than the constant irritation of a pin or other substance used to pick the ear. Many people are in the constant habit, when washing, of twisting up a corner of a towel or other cloth and pushing it as far as possible into the canal to clean it. Others use a small sponge on a stem for the same purpose. *All such methods should be abandoned.* The cleansing of the ear by the ordinary routine of washing and drying with the finger covered with the towel is always sufficient. The other methods only succeed in pushing the wax more deeply in and blocking the canal.

Symptoms.—A gradually increasing deafness may be the only sign. Noises, buzzing, rushing noises, &c., may be heard in the ears. Giddiness is a rare symptom, and can only occur when the accumulated mass presses unduly on the drum or parts of the canal. The collection of wax may be considerable without any marked degree of deafness, and the deafness may come on quite suddenly. This is due to the canal, which has hitherto never been quite closed, suddenly being quite blocked by a small piece of wax, or by swelling of the mass already there owing to the entrance of water. Pain is not common, though it may arise from the pressure of hard masses.

Treatment.—The wax is often easily dissolved by glycerine or warm oil. The canal should be filled up with either of these nightly. If this does not dissolve away the wax in a few days, then it will be easily removed by syringing. But in no case should the syringe be used without this previous use of glycerine or oil for several consecutive days to soften the waxy mass. A glass syringe, capable of holding not less than an ounce, with a blunt nozzle, is used. A few turns of cord round the wide end will enable one to hold it without risk of slipping. A bowl of warm water is used. The syringe is worked several times to see that it is in order. The patient sits sideways to the operator, who takes the ear between the finger and thumb of the left hand and pulls it gently backwards and upwards. This helps to straighten the canal. The end of the full syringe is placed in contact with the *roof* of the canal, *just inside its opening—not pushed far in*, that is to say,—and the water injected in a steady gentle stream, *never forcibly*. The process is to be repeated till all the wax is removed. Sometimes it comes away in large plugs, moulds of the canal. A bowl is held below the ear to catch the water as it escapes. As soon as all the wax is removed, the syringing should be stopped. Surgeons usually have a mirror for directing light up the canal to enable them to see when the passage is quite clear. Any person may use a small hand-glass for this purpose, reflecting the light up the canal, which is straightened by pulling the ear upwards and backwards. If this is properly done, the whole length of the canal is visible in the ears of most persons, and the white glistening drum is seen at the end. At least any person with moderate skill may see whether the canal is still occupied by the dark-brown masses of wax. When the syringing ceases, the canal is dried, and a small piece of cotton placed in it and kept for a day only. No drops of any kind are needed. In all cases where the presence of wax has not set up other changes, and when the ear is otherwise healthy, improvement of hearing should immediately follow removal of the wax, though some buzzing noises will remain for a short time as a result of the injecting.

Growth in the canal of the ear (*Polypus*). Growths are commonly the result of the irritation of discharges. They are soft red masses hanging from the walls of the canal, and may be no bigger than a pin-head or large enough to fill the canal. They cause deafness, and perhaps pain from pressure. They require cutting out.

Foreign bodies in the canal may be of very various kinds—beads, peas, small stones, insects, &c. Small bodies like beads may exist for a long time without producing any symptoms other than slight deafness and noise in the ear. If they are large, their pressure causes pain, and is liable to set up inflammation and discharge. A small pea may occasion such disturbance by swelling up with moisture and thus pressing on the walls.

Treatment.—Syringing with warm water in the manner described for the removal of wax is the only safe method that unskilled persons should adopt for dislodging them. If this fails, a surgeon should speedily be consulted. Much injury may be done by trying to extract the body with pins or other instruments.

Inflammation of the Drum of the ear results from the action of cold, cold water, or is due to injuries, to the pressure of masses of wax, foreign bodies, &c. Violent syringing for the removal of wax may set it up.

Its chief **symptom** is pain, often very severe, and worst at night, preventing sleep. Coughing and sneezing aggravate the pain; and in serious cases sickness and giddiness may be present, specially in children. Deafness, and noises in the ear, attend it. In children some degree of fever is commonly present. Ulceration and piercing of the drum is a consequence of the disease. If this is not properly attended to, permanent deafness may result.

Treatment.—It is of great moment that the case should be treated by a qualified person. The only treatment an unqualified person should undertake is the application of warm poultices to the side of the head, and the dropping of warm oil or glycerine or the 20-per-cent menthol oil into the canal of the ear.

Injury to the Drum is occasioned sometimes by the accidental pushing too far of some instrument with which the wax of the ear is being picked out. The membrane may be burst by a blow flat on the ear, by the explosion of artillery, or in the act of diving. It is, in these cases, caused by the sudden condensation of air in the external canal.

The accident is indicated by a loud crack in the ear, by sudden severe pain, giddiness, and noises in the ear. Deafness immediately follows. Some blood may flow.

Treatment.—The ear should be closed by cotton-wool. Nothing else should be done unless inflammation arise, which is treated as mentioned above.

Inflammation of the Middle Ear need only be mentioned. It has many forms, is very common, especially in childhood, and is the common cause of deafness. One of its forms frequently arises in scarlet fever; another form is the chief cause of "running ear." In its chronic form it tends to extend inwards to the membranes of the brain, thus causing death.

In acute cases pain is the first symptom. Children are very restless with it and feverish. They scream when the ear is touched. Giddiness and sickness are common; delirium and convulsions may attend it. Usually the parts behind the ear are very sensitive to pressure. In chronic cases there may be no pain, the chief element being the constant discharge.

Treatment in acute cases must be prompt and effective. The danger is so great that no delay should be permitted in summoning a surgeon. Till one can be obtained a strong dose of opening medicine should be given, and repeated if necessary; the patient should be confined to bed in a quiet room; and hot poultices should be applied over the side of the head, or a blister immediately behind the ear. Chronic cases require the ear to be continually kept clean by syringing, as described for removal of wax.

Earache attends all cases of acute inflammation of the ear, whether it is the external canal, the drum, the middle ear, or other parts that are affected. The presence of foreign bodies causes it; it may also be a form of neuralgia, or due to the irritation of a bad tooth.

The **treatment** consists in applying hot poultices to the side of the head, and in gently pouring warm oil into the canal. The 20-per-cent menthol oil, poured into the ear gives immediate relief in the majority of cases. A good application is made by filling a soft flannel bag with chamomile flowers, which have been steeped in hot water, and using it as a pillow.

Discharge from the ears (*Running Ears*) has been sufficiently referred to under INFLAMMATION OF THE EXTERNAL CANAL, and INFLAMMATION OF THE DRUM AND MIDDLE EAR. It ought never to be neglected, and all the more should it be carefully attended to if it has been long standing. It is an ignorant mistake that anything but good can arise from the stopping of a discharge as the result of appropriate treatment. If it stop of itself it may be because of some obstacle to the escape of the matter; and then naturally the pent-up fluid may quickly produce the gravest mischief. Parents and guardians who pay little heed to the "running ears" of their children are guilty of a very grave neglect of duty.

AFFECTIONS OF THE SENSE OF HEARING.

Deafness is a symptom of most affections of the ear. It may be due simply to accumulation of wax (see p. 489). When it comes on with a cold in the head, and a sense of "stopping in the head," it is the result of the cold (see

(Catarrh, p. 214), and is likely to pass off in a few days. Attended by pain, ringing in the ears, &c., some degree of inflammation is likely present (see p. 490). The most intractable form of deafness comes on very gradually and painlessly, and is connected with disease of the middle ear. Usually, also, it has gone on increasing for years before advice is sought. If a skilled ear-surgeon were consulted early enough, much might be done to stay its progress. The sudden loss of hearing caused by bursting of the drum, as the result of violence, will pass off as the tear in the drum heals.

Deafness due to disease of the nerve of hearing is usually very intense, comes on suddenly or advances very rapidly, and is not easily reached by treatment.

Noises in the ears are present in nearly every ear disease, but they are worst in diseases of the middle ear. They readily pass off in the affections of the external ear and drum when these diseases abate, and their treatment is that of the particular affection of which they are a symptom. The chance of their being got rid of, when they are occasioned by disease of the middle or internal ear, is small.

DEAF-MUTISM.

Inability to speak is in a large majority of cases the result of deafness. A person who cannot hear either the voices of others or his own has no inducements to utter words, and thus becomes dumb. It is naturally during childhood that this is specially shown. A child who has become deaf, as the result of disease, speedily loses the power to use language of which he had not yet obtained any mastery. A grown-up person, to whom the use of language has become a matter of habit, would not so lose the power of it, though he might lapse into silence, more or less complete.

Children may be born deaf, and thus never become able to utter the sounds of articulate speech. In a large number of cases, however, the deafness is the result of disease arising in the course of childhood.

The **causes** of the congenital form of deaf-mutism, that is of the form dating from birth, cannot be stated with certainty. It is important, nevertheless, to observe that intermarriage, the marriage of blood relations, is held to play a very serious part in the production of the defect. For example, it has been estimated that 10 per cent of the deaf in the United States of America are the offspring of parents nearly related. It is not necessary that the children of deaf-mute parents should also be deaf-mute, but the risk is considerable that they will be so, especially if both parents are deaf. This applies, however, only in those cases where the deafness of the parents arose before birth, and not where it has been the accidental result of some disease of childhood. The causes of deafness arising after birth are numerous. Scarlet fever is one of the commonest, because of the disease of the ear so rarely absent from this fever (pp. 490, 520). Next in order of frequency as a cause is disease of the brain, some form of meningitis (p. 154), or water in the head (p. 155), measles, typhoid fever, whooping-cough, mumps, scrofula, inflammation of the lungs, diphtheria, and accidents of various kinds.

Treatment.—It is sometimes the case that a child, apparently deaf, possesses some slight degree of hearing; and, in a few cases where the deafness is the result of some acquired disease, something may be done to improve the hearing. It is, therefore, of great consequence that parents should early detect defects of hearing in their children and promptly seek skilled advice. Where the degree of hearing is slight, parents are too apt to conclude that it is useless to attempt to train the child in the ordinary way, and to allow it to grow up as if it were absolutely deaf, teaching it by signs only. When the child can be made to hear by loud distinct speaking, close to its ear, the parents ought to take the utmost pains to teach it in this way, and ought to make use of signs as little as possible in order to enable it to acquire a knowledge of words.

There are two methods of teaching deaf-mutes, one by means of signs and by the manual or finger alphabet, called the French system; and the other by lip-reading and articulate speech, or the German system. In lip-reading and speech the deaf-mute is taught to put his vocal organs into the positions by which the various sounds are produced, and to understand what is said to him by seeing the position of the lips, mouth, &c., of the person speaking to him. This method has been attended with very considerable success, so that on leaving school the deaf-mute is able to converse with his teachers and intimate friends on ordinary subjects. In rare cases the deaf-mute is able to converse freely with strangers. The time required to attain moderate proficiency in lip-reading and speech is ten or twelve years, and the child should begin to receive instruction early, at the seventh year of age if possible.

A system of signs for instruction in lip-reading and speech has been designed by Prof. A. M. Bell of England, and extended and developed by his son Prof. Graham Bell of New York, the inventor of the telephone.

The modern system of caring for and educating deaf-mutes has shown that deaf-mutism is not necessarily associated with any degree of mental or moral defect. In some cases the defect is undoubtedly associated with feeble-mindedness, and is only one evidence of impaired development, but it is not necessarily so. With deafness one great avenue of the mind is closed up, and, if no effort is made to supply its place, the intelligence must suffer from want of development. If pains are taken to open up other avenues, education becomes as effective as if supplied through the channels of hearing.

Of recent years it has been clearly shown that a very large proportion of children, classed as deaf-mutes, have a remnant of hearing quite capable of being developed and extended. But each child requires individual instruction of the most patient and persistent kind. The cost of such training is considerable, as it is impossible in an institution with a large number of children, and requires a specially trained teacher devoted to the child in its own home.

Much work has been done in this department by Marage, of Paris, where also Marcel Natier and the Abbé Rousseau have founded an institute for the study of these conditions, and in Vienna, where Urbantschitsch has specially devoted his attention to the training of the deaf-mute to hear as well as to speak.

THE CARE OF THE EYES AND EARS.

The Care of the Eyes.—A common-sense rule should be applied to the eyes and ears as to other organs. We know that excessive use of a muscle produces a sense of tiredness, and that the sensible course is to give the muscle rest for a season. The eye may also be tired with much work, and on signs of fatigue showing themselves the organ should be rested. Some persons cannot read or write or otherwise use the eyes for close work without a feeling of pain and stiffness. This is often due to some degree of redness, and perhaps inflammation, of the lids; but it is more often a sign of some amount of long-sightedness. Persons who suffer in this way should, therefore, have their sight tested. Spectacles for reading or fine work may be found completely to relieve the feeling.

In reading or writing, or in similar occupations, the head should not be allowed to hang down and forwards. The way in which light falls on the work is of importance. It should come from the side, but so that the arm or hand may not intercept it. It ought not to be allowed to fall upon the face and eyes, or in any way to produce dazzling. The light ought to be sufficiently clear to render the work, writing, reading, &c., quite distinct without need of peering. Direct sunlight is bad, and so is a very brilliant artificial light. A mellow light, such as is given by a good reading-lamp, is best. Above all, the light should be steady and not flickering. For this reason much reading in railway carriages, or under similar circumstances, where complete steadiness is impossible, is injurious.

Under certain circumstances it is necessary to shade the eyes. In driving against a strong wind, for example, the eyes should be protected lest inflammation of the delicate membrane (conjunctiva) lining the lids and part of the eyeball be set up. For the same reason persons should guard against sitting in a railway carriage by the side of an open window, facing the direction in which the train is going, if there is any wind. The eyes should also be protected from the glare of a bright sun reflected from calm water when sailing, from similar glare reflected from white pavements in cities, and specially from the glare of the sun reflected from fields of snow. Spectacles of plane smoked glass are best for these purposes.

Children should not be allowed to read too long at a time; the table or desk at which they sit should be of a height to keep the head erect, and should be placed in the position referred to as regards the admission of light. Books printed in clear bold type should be placed in their hands so as to avoid straining their unaccustomed eyes, one of the most frequent causes of squinting (p. 485).

The Care of the Ears consists mainly in avoiding the use of pins, &c., for picking out wax. The necessary cleansing is sufficiently performed by the little finger or the corner of a towel. Wool should not be worn in the ears except when specially needed. It may be placed in the ears before entering water to bathe, and should be removed on coming out. Avoidance of vigorous nose-blowing will aid in preventing water that may have entered the nostrils from passing up the tube from the throat to the middle ear (eustachian tube, p. 464). No discharge from the ear should be left unattended to for a single day after its appearance (see p. 490).

SECTION XXIV.

ACUTE INFECTIOUS DISEASES: FEVERS.

Infection and Contagion:
- *The Relation of Living Organisms to Putrefaction and Disease*—Germs of disease—Micrococci, Bacteria, Bacilli, &c.—Their characters and mode of growth.

Fever or Pyrexia:
- *Its Cause and Character;*
- *Its Observation;*
- *Temperature Charts;*
- *Its Treatment by baths and drugs;*
- *Convalescence.*

Immunity:
- *Natural, acquired and artificial;*
- *Antitoxic Sera;*
- *Phagocytosis.*

Disinfection:
- *Disinfectants; Rules for Disinfection;*
- *How to disinfect* a patient's body, nurses' hands, clothes, discharges, rooms, &c.
- *Duration of Quarantine, and Isolation and Time for Disinfection in Infectious Diseases.*

Infectious Fevers attended by Rash (Eruption):
- *Scarlet Fever* (*Scarlatina*);
- *Measles* (*Rubeola*)—German Measles;
- *Small-pox* (*Variola*);
- *Vaccination* (*Cow-pox, Vaccinia*);
- *Chicken-pox* (*Varicella*);
- *Typhus Fever;*
- *Typhoid Fever* (*Enteric, Gastric, or Intestinal Fever—Bilious Fever*); Paratyphoid Fevers;
- *Dandy Fever* (*Dengue—Break-bone Fever*).

Infectious Fevers not attended by Rash:
- *Influenza* (*Epidemic Catarrh*); *Hay-Fever;*
- *Whooping-Cough* (*Chincough*—(Scotch) Kink-hoast);
- *Diphtheria and Croup;*
- *Relapsing Fever* (*Famine Fever—Seven-day Fever—Irish Fever—Bilious Remittent Fever*);
- *Plague* (*Pestilence—Pest—Black Death*); *Yellow Fever* (*Black Vomit—Yellow Jack*);
- *Hydrophobia* (*Dog Madness—Rabies*);
- *Glanders and Farcy;*
- *Syphilis;*
- *Cerebro-Spinal Fever* (*The Black Sickness* (popular, Dublin)—*Spotted Fever*).

Non-Infectious Fevers:
- *Ague* (Intermittent and Remittent Fevers—Marsh Fevers)—The Mosquito Theory; *Malta Fever.*
- *Sleeping-Sickness—Trypanosomiasis.*

INFECTION AND CONTAGION.

Formerly a distinction was drawn between diseases that were *infectious* and those that were *contagious*. The word infectious used to be employed in a vague way to imply the nature of a disease that could be communicated to a person without any apparent introduction of poisonous material into his body, a disease that somehow was about in the atmosphere; while a contagious disease was one which required the direct passage of the unhealthy stuff causing the disease into the body. This distinction has been broken down, and infection and contagion are now known to mean practically the same thing. The answer to the question, what exactly they do mean, opens up one of the most interesting and most recent chapters of medical science, a general account of which may be given.

INFUSORIA.

About the middle of the seventeenth century one Anton Leeuwenhoeck lived in the town of Delft, in Holland, as the steward of a judge there. He was accustomed to employ his leisure in making little lenses, wherewith he magnified and examined the structure of such things as butterflies' and gnats' wings. He had great skill of hand, and made several hundred lenses, each one to suit some particular object he wished to examine. With such a simple instrument, in April, 1675, did Leeuwenhoeck reveal a new and hitherto unsuspected world of living things. He placed under one of his simple microscopes a glass of rain-water, and perceived a multitude of variously-shaped bodies darting to and fro. Further experiments showed their presence in various organic (that is animal and vegetable) infusions. Hence these animalculæ, as their discoverer supposed them to be, have been termed **Infusoria**. But whence came they? Was it true, as the philosophers of antiquity believed, that organic substances, decaying animal and vegetable matter, with sufficient air and moisture, could, under the influence of heat, beget anew living things? Could "the sun breed maggots in a dead dog, being a god kissing carrion?"

Now it so happens that, thirty-seven years before Leeuwenhoeck's discovery, a similar question had been distrustfully put by a physician of Florence, François Redi, and had been triumphantly answered in the negative. Redi was not satisfied that the sun could "breed maggots in a dead dog" or in any other kind of dead meat, and he put the question to the test of an experiment as simple as it was conclusive. In hot weather he placed some fresh meat in a jar whose mouth he then covered with gauze, and in another but uncovered jar he placed a similar piece of meat; and he observed that while the exposed meat speedily swarmed with maggots, that under cover, though it became stinking, remained free of maggots. The maggots were not, therefore, the products of putrefaction, but their true cause was speedily apparent. For he noticed that multitudes of flies buzzed about the gauze, on which maggots were bred from eggs deposited there by the flies.

The maggots were, then, not the products of dead organic matter, but the direct offspring of living things. Could this explanation be applied to the infusoria of Leeuwenhoeck? and were they also hatched from eggs, or in some way the offspring of preceding infusoria like unto them? This was a much more difficult question, and not, at first sight, capable of a test so simple as Redi's. Moreover other observers flocked to the new field of investigation opened up by the microscope; the simple microscope was improved on; and, as the instrument became more and more powerful, smaller and still smaller living things came into view, till some were clearly revealed that would appear as mere points under Leeuwenhoeck's simple lens; while the modern compound microscope now discovers others as invisible to the simple lens as the infusoria are to the naked eye.

The problem to be answered does not alter with the diminution in size; the same question is raised, Whence come they?

In every organic infusion left standing for a day or two, more or less as the weather is cold or warm—in every organic infusion they swarm in myriads. Are they begotten by the mere breaking down, the decomposition, the putrefaction, the death and decay of the organic substance, or are they developed from eggs or in some other way the direct offspring of ancestors like themselves? Another very simple experiment seemed to settle the question, an experiment devised in 1748 by an English Catholic priest named Needham, in association with the French naturalist Buffon, but only perfectly carried out seventeen years later by an Italian philosopher, the Abbe Spallanzani. Its purpose was the same as Redi's, to keep an organic substance so that nothing could alight on it from without, in order to find whether, under these conditions, living things could develop within it. So minute are the organisms, however, that multitudes might be deposited, unseen, from the air during even a moment's exposure. With great ingenuity were the altered circumstances met. It was argued that heat would destroy the organisms, as it destroyed other living things. So an organic infusion was placed in a flask and boiled, and after it had been boiled for some time the neck of the flask was sealed by melting it in a flame, so that any living thing in the flask must have been killed and no fresh supply could enter. When this had been properly done, no animalcules ever appeared in the flask. The experiment is open to criticism. When one boils the infusion, the steam with which the flask is filled drives out the air, and by sealing the neck none can enter. It may be that living things can be spontaneously developed from organic infusions, but only in the presence of air, and the experiment has excluded air. In more ways than one was this criticism answered. In 1854 two German observers, Schroeder and Dusch, boiled organic infusions in flasks, but instead of sealing the neck of the flask they simply plugged it, when the steam was issuing from it, with a firm plug of cotton-wool. As the infusion cooled, air entered the flask, but was filtered on its way by passing through the wool. These infusions developed no living things. Than this even a more remarkable demonstration was given by the great French chemist, Pasteur, in 1862. He used a flask having a very long neck with a very fine bore. When the infusion was boiling he bent the neck downwards by the aid of heat. Air could freely enter, but it must pass upwards, not downwards. Any solid particles present in the air could not ascend with it, and so the air when it reached the infusion was free of them. In these flasks also no animalculæ were developed. But a second ground of criticism remains. It might be said, it is possible that an organic infusion which, before being boiled, might have been capable of spontaneously giving rise to living things, has been rendered incapable of doing so by the boiling, not because the heat has destroyed any eggs, seed, or other living thing from which a progeny could have been developed, but because the heat has somehow altered its constitution, just as heat will take the temper out of a spring. This too is easily answered. Break off the sealed end of the flask and leave the flask open but undisturbed, or remove the cotton-wool plug; in a few days the flasks, which for months, or for years maybe, have remained free from putrefaction, swarm with life. Or, as Pasteur did, drop a small fragment of the wool plug through which the air has been filtered into the infusion; within hours it is alive. Without doubt, then, the microscopic life that decaying animal substances contain in exuberant prodigality is not the outcome of some rearrangement of the particles of the dead matter, but is the product of previous life. But these and similar experiments reveal another fact—organic substances or fluids treated as in these experiments not only remain free from animalculæ but exhibit no sign of decay, no evidence of decomposition, no symptom of putrefaction. But let fall into the fluid from the point of a needle, or insert into the organic substance, a tiny speck of matter in which a microscope has exhibited animalculæ; at that point putrefaction begins, from that spot it spreads; decomposition wherever the organisms have contrived to push their way, no taint whatever in the spot to which they have as yet been unable to advance, but speedily pervading and permeating the entire fluid or solid till it is one mass of corruption. Thus, just as Redi showed that by excluding the blow-flies dead meat ceased to breed maggots, even so later experimenters have shown that by excluding the air, or rather by purifying it from the eggs or seeds, or whatever they be which throng in it, and which it sows on all it comes into contact with—by excluding or purifying the air the dead meat will likewise cease to stink.

This gives a very brief historical summary of the various stages in the discovery of new realms of life, whose inhabitants, though themselves invisible to our eyes, yet obtrude themselves by their ravages before our senses in various offensive ways.

They and their ways must now be described in some more detail, since their significance in men's lives is even more wide and appalling than the early experiments seemed to indicate.

BACTERIA.

The name infusoria was applied to the organisms discovered by Leeuwenhoeck, but the much more minute living things rendered visible by more powerful lenses were up to a late period all classified under the term **Bacteria**, which is a Greek word (*baktērion*) meaning a little staff.

Their excessive smallness is beyond one's power to imagine. Under the highest power of improved microscopes, which magnify about 4000 times, they appear like the periods and commas of ordinary type. If a man could be magnified by the same amount he would appear as huge as Mont Blanc or Chimborasso. In comparison to the size of an ordinary man a bacterion is as a grain of sand to Mont Blanc.

Workers with the microscope were not long in discovering that even among these smallest forms of life there was as great variety as among higher and larger forms. Indeed differences which they manifested were too great to permit them to be placed all together as members of the same class or order. Various classifications have been proposed for them, which it is unnecessary to state here. It is desirable, however, to note and remember several of the chief types. The differences which exist between them are largely in size and form, to some extent in mode of multiplication. In one thing they all agree. They all consist of a kind of protoplasm, a jelly-like substance, which is clear and transparent, without any indication whatever of separation into organs, but exhibits sometimes fine granules. The protoplasm is inclosed by a membrane, which may be very dense and impenetrable, and capable of resisting the action of acids and alkalies and of heat and cold.

All the various kinds are grouped together as **micro-organisms** (Greek, *mikros*, small), **microzymes** (*mikros*, and *zumē*, yeast), or **microphytes** (*mikros*, and *phuton*, a plant), **Bacteria** is also a general name for the special group which we are considering.

That group of micro-organisms—the **Bacteria**—consists of three chief types:

1. The **micrococcus**, or round organism;
2. The **bacillus**, or rod-shaped organism; and
3. The **spirillum**, or spiral organism.

The **Micrococcus** (*mikros*, and *kokkos*, a berry) is round, and sometimes no larger than the 32,000th of an inch in diameter. It grows after a fashion common to the other forms. The body becomes narrowed in the middle, as if by a band tied round it. The constriction increases until the single round body is almost divided into two. In a brief time the connecting thread is severed and the organism is completely split into two, each of which now has an independent existence. In a short time each one of the two divides, so that from the original *one* there are now produced *four*. This process of multiplication is called **fission**. Different kinds tend to divide in different directions. One kind dividing only in one direction forms chains – **streptococci**; another growing by division in several directions forms grape-like clusters — **staphylococci**; another dividing regularly in three directions forms masses like bales of cotton tied lengthways and across — **sarcinæ**; and sometimes they develop in pairs—**diplococci**. Sometimes they form masses, held together and embedded in a jelly-like substance—**zooglœa** mass.

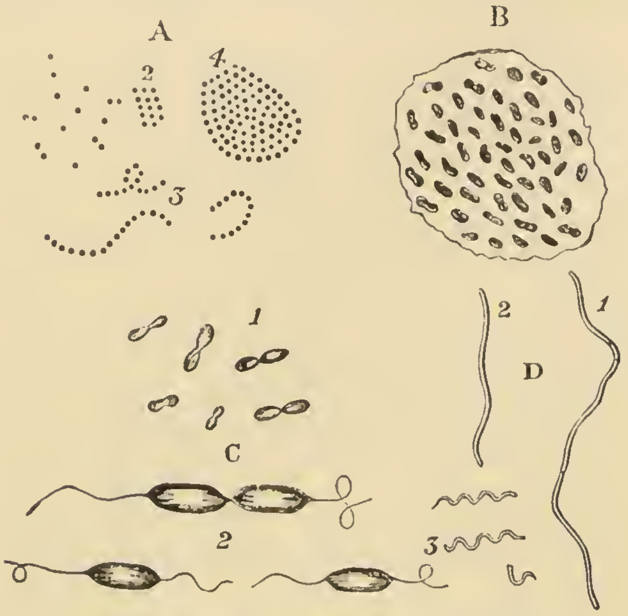


Fig. 198.—Various Species of Micro-organisms.

A, Micrococcus: 1, singly; 2, in groups; 3, in chains; 4, in mass. B, a mass of Bacteria (Zooglœa mass). C, Bacilli with rounded ends: 1, singly, constricted in the middle, as about to divide into two; 2, shows, in a much more highly magnified view, the way in which one organism divides into two, each half passing off as an independent form. It also shows the flagella, or lash-like tails. D, 1 and 2, Vibriones; 3, Spirilla. All are very highly magnified, and in different degrees. (After Klein and Dallinger.)

The **Bacillus** (Latin, *bacillum*, a little rod) is rod-shaped, about $\frac{1}{10{,}000}$th of an inch long, and a third less in breadth, and it has rounded ends in some species and blunt ends in others. Some of them are provided with fine tail-like processes, one or more at each end, by the lashing movement of which they may move from place to place in fluids. It multiplies like the micrococcus by dividing. The process is shown in Fig. 198, C. When the division of one into two is almost complete, only a long thread connects the two halves. This finally breaks in the middle, and each half moves away as an independent being. Dallinger has shown that, besides growing in numbers in this way, they may multiply in another fashion. He has watched two organisms meet and become fused together into one mass, losing their tails and becoming motionless. After a time the mass looks very granular. Finally it bursts, and there pours out a cloud of exceedingly fine particles. After watching the cloud of particles for some time Dallinger saw fully-formed organisms issuing from it. In fact the particles were spores or seeds, which, in a sufficient time, with the aid of heat, moisture, and nourishment, developed into the adult forms. This is **multiplication by spore formation**. In two ways, therefore, bacilli multiply. Bacilli are particularly apt to form long chains or threads, being strung on end to end as they increase in numbers. Fig. 199, A 1, shows three bacilli. At 2 is seen a chain. In the body of each bacillus is seen a bright oval dot. This represents a seed or spore. It increases in size at the expense of the jelly-like material forming the substance of the organism, till it bulges out the inclosing membrane. At last the membrane bursts, and the spore is discharged. If it is surrounded by nourishing material it will develop into the full-grown bacillus. If not so favourably placed it may still retain its vitality. In fact spores may be exposed to all kinds of unfavourable conditions—to cold or to heat; they may become dry and be dispersed as dust. But let this apparently lifeless dust be brought into favourable conditions of moisture and warmth, with nourishment at hand, and forthwith the spores will grow, and adult forms will be produced from them in abundance. Fig. 199, B, shows bacilli with spores, and a mass of spores.

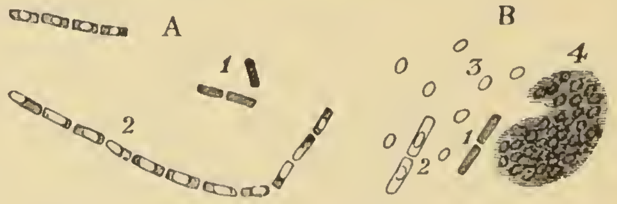


Fig. 199.—The Bacillus of ordinary putrefaction.

A, 1, single bacilli; 2, bacilli forming threads and developing spores. The bright oval body in the centre of each bacillus is a spore. B, 1, ordinary form without spores; 2, with spores; 3, free spores; 4, a mass of spores. (After Klein.)

The **Spirillum** is a long, well-marked spiral; the **Spirochaete** is similar (Fig. 198, D 3).

The **Vibrio** (Fig. 198) is a variety of the spirillum, and is a rod-shaped, jointed organism, presenting undulations, but not the marked cork-screw appearance of the spirillum.

All of these, we have seen, multiply by one of two ways, either by division or by the formation of spores, but the rapidity of their increase is beyond conception. In one brief hour, under favourable conditions, one may perceive the whole progress of their life-history. Here is a comparatively simple calculation, but one whose results are so enormous that the authority of one of the most distinguished of investigators is given for its accuracy, that of Prof. Ferdinand Cohn of Breslau. Given that one bacterium will divide into two in one hour, then each of these two in another hour will divide, making 4, after three hours there are 8, and so on. At the end of 24 hours, from one bacterium there are developed 16½ millions (16,777,216). After 48 hours the number amounts to 281½ billions, and after 3 days to 47 trillions. Into a flask containing a clear, transparent, organic fluid, and under favourable conditions, sow a drop of water containing but one bacterium, and such as this is the result. Nevertheless the multiplication is not indefinite; it is indeed strictly limited. It is from the contents of the organic solution that the bacteria obtain the nourishment for their life and growth. As soon as they have exhausted the nutriment, they can no longer multiply, and will speedily cease to exist.

Accompanying their multiplication changes take place in the clear fluid which are quite visible to the naked eye. It becomes muddy, turbid, and loses its transparency. When the bacteria have exhausted the nourishing material, they fall to the bottom as a deposit, and the fluid may become again quite clear, but altered in constitution, because its complex constituents have been rent asunder to supply food to the organisms.

RELATION OF LIVING ORGANISMS TO PUTREFACTION.

Now two questions arise—questions which have been already alluded to in the historical sketch given on pp. 493, 494. They are these: What is the origin of these bacteria? and what is their relation to putrefaction, from which they are never absent? To each question there are two answers: to the first, as to the origin, the old answer is expressed by the phrase: "spontaneous generation;" that is to say, organic substances may give birth to them under certain conditions of heat and moisture; the modern answer is: They have always parents like to them. To the second question, their relation to putrefaction, one answer is: They merely accompany it; the other is: They cause it, and without them it cannot be. Now, in spite of experiments like those of Schroeder and Dusch, men of high scientific attainments held and yet hold the view of spontaneous generation. It does seem absurd to believe that one cannot expose anything to the atmosphere for a single instant without there being deposited on it invisible particles of dust, including seeds, spores, or germs of bacteria or bacteria themselves, which await only a favourable opportunity to develop and attack, if it is liable to attack, the substance to which they have adhered. But this apparent absurdity, by a series of beautiful experiments, was shown by Prof. Tyndall to be a fact. Everyone knows that if a room be darkened by closing the shutters, and if a beam of sunlight be allowed to enter by a chink or crack in the shutter, its track will be revealed by myriads of dancing motes that catch the light and disperse it. The track of a beam of the lime or electric light will be shown in the same way. But for these dancing particles of dust the light would only light up the object on which it fell, its pathway would be invisible. Tyndall constructed a chamber whose top, floor, back, and sides were of wood, and whose front was of glass. In the floor were openings through which test-tubes were passed, their mouths opening into the chamber. A strong beam of light was thrown into the chamber, its path being clearly visible owing to the dancing particles. The chamber was then allowed to stand undisturbed; and three days later, when a beam of light was again thrown into it, *its pathway was invisible.* This showed that the air was perfectly free from suspended particles, which had all attached themselves to the sides or fallen to the bottom of the chamber. Into the test-tubes an organic fluid, capable, therefore, of decomposition, was carefully poured through an opening in the roof. The projecting ends of the tubes were allowed to dip into a bath of brine, which was boiled for 5 minutes. The bath was then removed and the chamber allowed to remain. For months it stood, the fluid showing no signs whatever of putrefactive change, while the fluid in similar tubes, subject to the same treatment, but standing in the open air of the laboratory, rapidly decomposed. But a few days after the chamber had been disturbed, so as to raise the dust, the fluid in every tube gave way and was found to swarm with bacteria. Experiments with all sorts of infusions gave precisely similar results. Moreover, Tyndall showed that air strained through cotton-wool, or heated by passing through a red-hot tube, no longer revealed the pathway of the beam of light—was deprived, that is, of solid particles, thus explaining fully how air admitted to flasks plugged with wool did not produce decay in any organic material in the flasks. In truth these and multitudes of other experiments show convincingly that the air is everywhere laden with solid particles, including germs which, sown on suitable soil, rapidly multiply, their multiplication being accompanied by all the stages of putrefaction. They exist everywhere, but more thickly spread in towns than in the country, becoming fewer as one recedes from human habitations; but they are present, nevertheless, in the atmosphere far removed from human dwellings, on the heights of the Alps as in the most densely-peopled valleys.

It is by the French chemist Pasteur, however, that the most complete and brilliant series of experiments was performed that disposed of the theory of spontaneous generation.

He was led to these experiments by studying the action of yeast. Leeuwenhoeck had noticed little round bodies in beer, and in 1837 Cagniard Latour had observed that the fermentation of beer was accompanied by the growth of these little bodies. They are called torulæ, and are not bacteria. They are round or oval, and multiply by budding. But Pasteur proved that the fermentation was the expression of the active life of this small cell; that, to obtain certain materials requisite for its nourishment, it attacked the sugar present in the fluid, and, as a result of splitting it up, produced carbonic acid and alcohol. From the fermentation of beer he passed to the butyric and lactic fermentations—actions whose results anyone may see by watching the process of the souring of milk. He demonstrated that in each case the fermentation was the work of an organism introduced from without. The production of vinegar he showed to be also the work of a bacterium. Introduce yeast into beer-wort, it grows and flourishes, and alcohol and carbonic acid gas are formed. But the yeast soon exhausts the material on which it grows, and immediately its own activity ceases. But it has not exhausted the capacity of the liquor to nourish various other kinds of living things. This is the golden opportunity of bacteria, which may then become active, and, by the fermentive process they in turn set up, beer becomes sour. Beer, vinegar, and wine in turn received Pasteur's attention, and in each case he separated the living agent, different in each, whose growth was the direct cause of the change. Let bacteria foreign to the fermentation proper in each case be introduced, and beer becomes sour, vinegar becomes flat and tasteless, wine is converted into vinegar. These questions were inextricably interwoven with the wider one of spontaneous generation. This Pasteur also attacked by means of such experiments as have been indicated, though not in their historical order, and which Tyndall's experiments, performed later, amply verified, so that Pasteur was able to declare: "There is not one circumstance known at the present day which justifies the assertion that microscopic organisms come into the world without germs or without parents like themselves. Those who maintain the contrary have been the dupes of illusions and of ill-conducted experiments, tainted with errors which they knew not how either to perceive or to avoid. Spontaneous generation is a chimera."

But many observers have taken organic infusions—an infusion of hay, for example,—have boiled them in flasks, duly sealed the necks, and have laid them aside, and yet, after a sufficient time, bacteria have been found in them multiplying. Such results have been obtained by the most experienced observers, when no doubt existed as to the experiments being well conducted. The explanation in due time was forthcoming. The fully-developed bacteria are destroyed by a temperature much below that of boiling water; not so their spores. These seeds, or eggs as one may call them, resist the temperature of boiling water, prolonged even for several minutes, and in some cases even for hours, so that, when set aside, by and by the boiled infusion will give way, owing to the growth of the eggs to the fully active bacteria. Indeed they are unusually resistant, defying the action not of heat only, but also of extreme cold. One may freeze the solution containing the bacteria, one may keep them for hours at a temperature many degrees below zero: the bacteria themselves die, but their spores are only dormant, and will awake up to life soon after the usual temperature is restored. Drying they successfully encounter as well as the action of many chemical agents.

Thus one objection after another has been set aside, till it becomes conclusively evident that there is present in the atmosphere a vast number of germs of various kinds, each kind capable of setting up a fermentation peculiar to itself; that putrefaction is only one kind of fermentation, the expression of the life and growth of a particular germ whose activity liberates from the organic substances on which it lives sulphurous and other badly-smelling gases; and that, if by any means the organic substance is kept free of the living things, it will not putrefy, will not break down, but will remain in its organized though lifeless condition.

From this point of view the germs of putrefaction cease to be mere interlopers, parasites, breeders of corruption. They come to occupy a recognized and legitimate place in the constitution of nature. Nay, not only do they fill a recognized place, but they discharge a necessary function, they play, indeed, a beneficent part in the drama of life. The world of lifeless matter consists—let it be put roughly and broadly—of a number of elements—carbon, oxygen, hydrogen, nitrogen, sodium, potassium, phosphorus, sulphur, &c.—associated together in various ways, oxygen and hydrogen as water, oxygen and nitrogen as atmospheric air, potassium, sodium, phosphorus, in various combinations as salts of various kinds. Now these substances are just such as plants, the lower animals, and man require for their nourishment. But neither the lower animals nor man can take these inorganic substances and convert them into the living matter of their bodies. A diet of phosphate of lime, chloride of sodium, and potassium, charcoal, and so on, with a liberal allowance of air and water, though containing the same elementary substances as are found built up into muscle, nerve, and bone in a human body, is but as the sand of the desert to a hungry man. Six feet of earth may be a liberal allowance for his grave, but not for his repast. Not so with the plant. From the earth in which it is rooted, from the air to which it stretches its arms, it draws just the same elements as have been named, and builds them up into much more complex forms, into highly organized substances. On these complex combinations of the same original elements animals and man can live. The ox crops the herbage and builds up in its own body, into still higher forms, the organic substances the plant yields to it; and man in turn derives nourishment from the substances the plant and the lower animal prepare for him, composed though they be of the same materials which, as beggarly elements, are practically valueless for him. And now, what would happen suppose there was ever a building up and never a breaking down? The plant, which is the first workman in nature's great manufactory, which performs the first stage in the process of converting the raw material into the finished article—the plant cannot live on boiled mutton, nor yet can it feed on the bodies of its dead companions. It is the elements it seeks. But if it is perpetually building up the elements into organic substances its own supply of nourishment will some day be exhausted, it will cease to live. If balance is to be maintained, the process by which organized bodies are broken down into elements must keep pace with the process by which elements are built up into organized bodies. Death is necessary to life. This breaking-down process the lower animals and men to some extent accomplish. A man eats bread and meat, he takes into his body complex substances, he transforms them into material for his use; they abide in his body for a longer or shorter time, give him the means of obtaining heat and energy, and are then cast out, as carbonic acid gas, water, urea, and salts—practically restored, that is to say, to their elementary form, broken down from their complex state. But animals and men die. Their bodies are masses of complex, organic substances, in that form useless for any practical part in the cycle of life. But now, to sweep away this useless mass an invisible host of busy workers descend from the air, who take possession of the body, send detachments far and wide into its inmost recesses, and rest not day nor night till they have rent asunder from one another the wondrously piled molecules of albumen, of fat, of nerve, of blood, till they have broken down the walls and torn from one another the stones of the tabernacle of flesh—till they have restored again to earth and air that which years before the plant took from them. No putrefaction without organisms; and thus life presides over the work of death.

RELATION OF ORGANISMS TO DISEASE.

Now, these facts that have been stated supply the foundation of the modern view of infection and contagion. The resemblance between fermentations and putrefactions and various diseases, specially those of an infectious or contagious sort, had long ago been remarked; and if the one set of occurrences was the work of organisms or germs, why not the other? Why not? In 1850 a French doctor, Davaine, on examining with the microscope a drop of blood from a patient who had died of splenic fever, observed little thread-like bodies about twice the length of a blood corpuscle. He paid little heed to his discovery. But in 1863, excited by the proof Pasteur had meanwhile offered of organisms of a similar nature being the cause of various fermentations, he made new observations, and found the same thread-like body constantly present in the blood of sheep and rabbits dead of the disease. These are the first definite observations that link contagious diseases to the life and growth of germs.

Now it so happens that about the same time ruin was threatened to one of the industries of France, that of silk culture, by the presence of a mysterious disease among the silk-worms that spread like a plague not only in France, but in Spain and Italy as well. In 1865 the loss to France by its ravages amounted to over four million pounds sterling. In the distress the Government of France turned to Pasteur, who had taught the French wine-growers how to prevent disease in their vines, and besought him to render his assistance. He visited the affected districts, and was speedily able to affirm that the disease was due to the presence in the insects of minute cylindrical bodies about $\frac{1}{6000}$th of an inch long, and therefore only discoverable by the microscope. These microscopic organisms had been observed years before by an Italian naturalist, Filippi; but whether they had any connection with the disease was not known. Pasteur proved they were the cause of the disease, and that it was contagious. He showed that if a silk-worm, in whose body the round bodies were present, was pounded up with water in a mortar, and the poundings painted with a brush on the leaves on which healthy worms were fed, they would all without fail be smitten with the plague. For three years he worked at silk-worm disease, and succeeded, with grievous injury to his own health, in unearthing its precise nature and in devising means for its arrest, by the adoption of which prosperity was restored to this industry. During this time, and for some years after, a hot discussion had been going on about Davaine's discovery of bacilli in splenic fever. In 1876 a young physician living near Breslau, Dr. Koch, published a paper giving a full account of the life-history of the splenic-fever bacillus, and a complete demonstration that its introduction into the body of animal or man was the only cause of the disease. In the following year (1877) Pasteur, driven into the question of contagious diseases by his experiments on beer, wine, and silk-worm diseases, investigated the question, and confirmed and extended the results of Koch. Now, what of splenic fever? It may attack the horse, the cow, the sheep, and man. In some years France lost by it in cattle from a half to one million pounds sterling. It is rampant, not in France only, but in Spain, Italy, Russia, and Egypt. It has appeared in this country, *transported from Russia by hair.* It is sometimes called *wool-sorters' disease*, because in this country it has been chiefly wool-sorters that have been attacked by it. The evidence is conclusive that the hides had been those of animals dead of splenic fever. Some of the blood of the animal containing the germ that is the cause of the disease had soiled the skin, and the bacillus had produced spores. These seeds had clung to the hairs, and, in spite of drying, had retained their vitality. In the process of sorting they had been detached and had gained entrance to the bodies of the sorters by the air breathed.

Culture of Organisms.—What is the general method adopted in investigating the nature of micro-organisms? By the use of very highly magnifying powers, and by the use of staining agents, they can be seen under the microscope. In the blood of an animal dead of splenic fever an organism was discovered by means of the microscope, but no information could thus be gained as to its relationship to the disease. Often, moreover, various kinds of such living things were found, and the question arose which kind, if any, was it that produced the disease.

Experimenters, therefore, attempted to grow artificially the different organisms. Some flourish and multiply in chicken-broth, others grow well on gelatine, some on raw potatoes, while various other solids and fluids were found capable of nourishing them. Experiment showed, moreover, that a particular form of organism flourished so well in one particular fluid that, though this kind with many others were put into a flask of the fluid, the particular form took entire possession of the fluid, and no other had a chance of life against it. Here, then, was a method of sifting out one kind from another, until a fluid containing one form only was obtained with which to experiment. Thus a drop of blood taken from an animal dead of splenic fever is placed in a flask containing meat-broth, which has been shown to be free of germs of all kinds by having stood for several days or weeks, after being boiled, without the least trace of decomposition occurring in it. The flask is plugged with wool, and is maintained at a certain heat. In a few hours the bacilli of splenic fever, present in the drop of blood, have multiplied enormously. If other kinds of organisms were present in the drop they may have grown too, but to a less extent, because the soil, so to speak, is not so suitable for them. From this flask a drop of fluid is taken and transferred to a second flask containing the same pure broth free of germs. The special bacillus multiplies here again, other forms less. From the second flask a drop is transferred to a third, and so on through six or seven flasks, till a fluid is obtained containing the one particular organism only, all the others having died out. This flask now contains what is called a pure cultivation. Now if the bacillus contained in this fluid is the cause of splenic fever, then the injection of a small quantity of the fluid into an animal, capable of taking the disease, ought to produce the disease in the animal. If it produces the disease, then in the blood of the animal the same bacillus should be found, and from a drop of the blood new quantities of the organism ought to be capable of being reared, by means of which, in turn, the disease can be again communicated. All these different processes must be gone through before it can be said with perfect certainty that the particular germ is the active cause of the particular disease. Besides all this, it is plain that when a cultivation of the germ is obtained, experiments may be performed to determine what substances hinder and what aid its growth, whether carbolic acid, Condy's fluid, or other agents kill it, and so on. By such means information may be gained that would enable the disease to be arrested or stamped out.

A remarkable illustration of this may be given from Pasteur's work. He found that hens never took splenic fever, and that the disease could not in an ordinary way be communicated to them. Now a degree of heat equal to 44° Centigrade kills the splenic fever bacillus, and the heat of hen's blood is 41° or 42°. He thought perhaps the high temperature of the fowl's blood prevented it from taking the disease. So he took a hen and placed it in a cold chamber till its bodily heat was lowered to 37°. He then injected the poison; it took the disease and died. He did the same with another fowl; but this time, at the height of the attack, he placed it in a warm chamber to raise its bodily heat up to or above the usual. It recovered. But, again, Pasteur found that an animal that had recovered from one attack of splenic fever was safe from a second attack. He found that he could cultivate the splenic bacillus through hundreds of generations without its violence being the least affected, provided one cultivation followed another within an interval of hours. If, however, a cultivation of the organism were left for days or months with a due supply of pure air, its violence was remarkably diminished, and *if this weakened bacillus were injected into an animal the animal was very slightly affected for a short time, but was rendered incapable of acquiring the fatal form of the disease.*

Pasteur announced his discovery; he was offered a test and accepted. In May, 1881, in the presence of veterinary surgeons, agriculturists, and others, a flock of 50 sheep and 10 cows were brought before him. Into the bodies of 25 sheep and 6 cows he introduced some fluid containing the weakened germ, the remaining 25 sheep and 4 cows were untouched. Three weeks later the most fatal form of the poison was injected into the bodies of all the 50 sheep and 10 cows. Two days later the 25 sheep that had not received the weakened germ were dead, and the 4 cows were very ill, while the 25 sheep and 6 cows which had received it were comfortably browsing. Since that day, up to the end of 1883, more than half a million of animals were vaccinated (so to speak) in France against splenic fever, with a consequent reduction of the death rate from that disease to $\frac{1}{10}$th of what it was among non-vaccinated animals.

Briefly, then, splenic fever has been found to be due entirely to the presence in the body of the affected animal of a particular living organism, and the result of that knowledge has been to indicate the means for stamping out the disease.

The true nature of another disease, tuberculosis, has within recent years been revealed by methods of inquiry similar to those just described, pursued by the distinguished German observer, Dr. Koch. It has been stated (p. 372) that tubercle is the chief cause of consumption of the lungs and of the bowels, and of some forms of inflammation of the membranes of the brain (p. 155). In the little nodules of tubercle (p. 375) Koch found a small bacillus (fig. 200). He was able to grow it artificially; and, by injecting fluid containing his reared germs into animals, he reproduced the disease. In the spit of consumptive patients

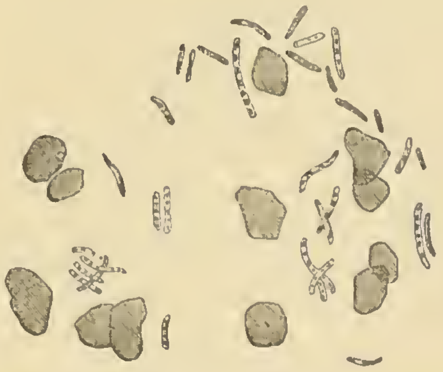


Fig. 200.—Bacilli in Spit of Consumptive Patient.

the germ is found (Plate XXI.). The seeds of the germ are not destroyed by drying, so that when the spit has become dry the seeds may be wafted about in the air, may be drawn into the lungs of a healthy person, and produce the disease. The popular objection, therefore, to sleep with, or be the close companion of, one suffering from consumption, is not without scientific justification. But the germ of tubercle needs a high temperature for its development, and it is not, therefore, likely to thrive in the atmosphere in temperate climates.

After the epidemic of cholera in Egypt in 1883, which spread to France, Italy, and Spain, investigations were undertaken to discover whether any special organism could be detected as its cause. French, German, and British commissioners were appointed for the purpose. Dr. Koch, who was head of the German commission, discovered an organism, a bacillus, or spirillum, shaped like a comma (,)—the "comma bacillus," or "cholera spirillum,"—in the intestines of persons who had died of cholera, in the discharges from cholera patients, and also in water of which persons had drunk, who had afterwards been seized with cholera. He believed that this was the active agent in the production of the disease. Animals, however, are not susceptible to cholera, and the essential link in the chain of evidence, namely, the production of cholera in animals by the injection into their bodies of the pure cultivation of the organism, could not be obtained. In 1885 Dr. Klein, the head of the British commission, reported as the result of his investigations his inability to accept Dr. Koch's view. At present, therefore, the relation of micro-organisms to cholera is not definitely determined.

Malarial fever is due to an organism, though it does not belong to the bacteria (p. 548).

In the blood of persons suffering from relapsing fever spirilla have been found in great numbers, and during the intervals of freedom from fever they disappear from the blood. The fever has been produced in monkeys by injecting into their bodies blood from persons suffering from relapsing fever, and thereafter the spirilla have been found multiplying in the monkey's blood.

In 1884 a bacillus was proved to be the cause of diphtheria.

A micrococcus has been found in erysipelas, and the injection of the reared organism into rabbits produces erysipelas in them.

In the annual reports of the Registrar-General the following diseases are classed as zymotic, that is, as resembling fermentations, and apparently due to some poison operating in the blood, which poison might consist of living organisms such as have been described:—

Small-pox.
Measles.
Scarlatina.
Diphtheria.
Quinsy.
Croup.
Whooping-cough.
Typhus.
Enteric or Typhoid.
Simple Continued Fever.
Erysipelas.
Puerperal Fever.
Carbuncle.
Influenza.
Dysentery.
Diarrhœa.
Simple Cholera.
Ague.
Remittent Fever.
Rheumatism.

Micrococci have been found in small-pox, scarlet fever, diarrhœa of children, and Malta fever. Bacilli have been found in dysentery and typhoid fever. Probably in time research will reveal the connection between all infectious disease and the growth of micro-organisms. How, precisely, the organism operates in the production of the disease it is not easy to determine. It seems probable that the multiplying organism produces some chemical alterations in the blood and tissues of the animal attacked; and it may be that, in the course of its own growth and multiplication, the organism produces some special substance which acts as a poison, and that it is owing to the operation of this poison, or **toxin**, that the symptoms of the disease are manifested (see p. 504).

These considerations have some very practical issues. Every infectious or contagious disease appears to be due to some form of micro-organism, one particular organism for each particular disease. Each organism produces its own disease and none other; and the special disease cannot arise unless its germ has gained entrance to the body. They may gain entrance in many ways. They may be present, like putrefactive germs, in the air, in food, in drink. They may be received on one's clothes; they may be harboured under one's thumb-nail; a hostess may dispense them with her hospitality; a friend may impart them by a kiss. But, though the channels by which they spread are inexhaustible, *they have one origin and one only*, and that is a preceding case of disease. The organisms enter the body of a person and multiply there. They are cast off from his body, some by the air which he breathes out, some by his skin, some by the kidneys, some by the way of the intestinal canal. One kind of germ may be particularly abundant in the discharges, may be able to multiply in organic fluids, so that the smallest quantity of such a fluid gaining entrance to food or drink is capable of imparting the disease to those who partake. Another kind of germ, on the other hand, may be drowned, so to speak, in liquid, and may rather be propagated by spores suspended in the air. But that is a mere detail in the life-history of the germ. In all cases, however, it is the introduction of the organism into the body that sets up the disease.

This view of infectious diseases thus affords the hope and suggestion of a method of diminishing, if not of getting rid of, such diseases altogether, and to some extent also indicates the direction in which their cure is to be sought. If the particular organism of each contagious disease were known, and the conditions of its life and activity understood, there is great probability that this knowledge would at once suggest a method by which its multiplication in the living body could be arrested, and the disease thus cured. The method of treating some infectious diseases by **vaccines** (see below), or by **antitoxins** (p. 513), illustrates this. Even without such knowledge, however, the view indicates the means for arresting the spread of contagious diseases and diminishing their occurrence. Too often, however, one case is the breeding-ground of a multitude of others, because no steps are taken to prevent the scattering abroad of the germs. To prevent such an occurrence methods are adopted for destroying the disease germs that have proceeded from the patient's body. These methods are stated under DISINFECTION.

Two misunderstandings must be guarded against. In the early part of this article the grounds were stated for the assertion that the organisms of putrefaction were everywhere, and could not be avoided. There can be no doubt that everyone daily swallows and draws into the lungs hundreds of them. These germs of putrefaction are powerless to harm the living human body. Moreover, by no possibility, it would appear, can such organisms be changed into forms capable of acting in a poisonous manner on the living body. To repeat, it is not the ordinary germ of putrefaction that does harm; it is a particular form of organism for each particular disease. The second point to be noticed is that disease germs may gain entrance to a person's body and yet he may not suffer from the disease. Just as in nature each plant grows best in a particular soil, and in some kinds of soil certain plants cannot grow at all, so disease germs may enter a person's body but be unable to thrive there. In other words, the person is able to resist the disease. (See **Immunity**, p. 513.) Just as there are soils that will grow anything, so there are persons who catch everything that is going.

Nothing gives a man so great disease-resisting power as good health. That man secures himself best against infectious as against other disease, who, besides keeping far from the source of the infection, lives regularly and temperately in diet and in conduct.

Vaccines.—Some diseases are successfully treated by the use of an emulsion of the organisms, whose operation is the cause of the disease. A pure culture of the organism is made. An emulsion of the pure culture is then produced by rubbing it up with sterile water. The emulsion is then heated to kill the organisms; and an antiseptic is added to preserve the mixture. The strength of the emulsion is then determined by estimating the number of organisms contained in a fixed quantity.

A particular disease is then treated by injecting, under the skin, a small quantity of such a preparation of organisms to which the disease is due, and this injection is repeated at definite intervals in increasing doses. Such vaccines are employed both to prevent disease, that is to confer immunity, and to cure disease already present.

In treating a disease already present, it is best to find and identify the organism attacking the particular patient, to make the culture of it, to produce a vaccine from this culture, and then to inject this into the patient. This is called an **autogenous vaccine**, that is a vaccine produced from the very organism attacking the particular person. It is, of course, a somewhat elaborate process, requiring special methods not always ready at hand. There are in the market standard vaccines for the treatment of various ailments in this way, of which the following is a list:—

Anti-pneumococcic vaccine, for the treatment of pneumonia,

Anti-streptococcic vaccine, for the treatment of suppuration and abscess,

Anti-staphylococcic vaccine, for the treatment of acne, boils, and carbuncles,

Anti-typhoid vaccine, for the *prevention* of typhoid.

Influenza may be treated in this way, and also some forms of bronchial and nasal catarrh, and there are some ailments believed to be due to an organism found in the large bowel — **colon bacillus**—for which also a vaccine is prepared.

Epidemic and Endemic.—It is the fact of contagion that gives the peculiar character to diseases called **Epidemic** diseases. One person affected with small-pox comes into a community. In a short time others catch it from him. Each one of these communicates it to others, and thus the disease spreads among the people. It becomes epidemic (Greek, *epi*, upon, and *dēmos*, the people). Small-pox, measles, and scarlet fever are thus types of epidemic diseases, diseases capable of over-spreading a community in a brief period. On the other hand, such diseases may appear here and there, not spreading for some reason or another, but an odd case occurring unconnected with others, so far as known. Such cases are said to be **sporadic**. In opposition to epidemic is the word **endemic**. The essence of an epidemic disease, as we have seen, is a poison, capable of multiplying in a human body, and of being passed from person to person, communicating the disease. Now an endemic disease is not one which can be so passed from one person to another regardless of place. It is linked with some particular district, so that a person is not liable to it unless he comes within the affected district, and perhaps by leaving the district he may get rid of it. It depends, that is to say, upon some peculiarity of climate, of water-supply, or drainage of the district in question. Thus goitre (p. 287) affects persons living in certain parts of Derbyshire, in certain Swiss valleys, &c., and persons will not be affected by it if they keep away from the localities where it prevails.

FEVER: ITS CAUSE AND CHARACTER.

This is a suitable place in which to discuss some of the features of fever in general, apart from any particular kind of fever.

Pyrexia is the technical word for fever—it is a Greek word meaning feverishness—while **hyperpyrexia** means high fever. The adjective is **pyretic**, and means febrile, while **apyretic** is also an adjective, meaning without fever; and **antipyretic**, meaning opposed to fever, is the term applied to any kind of remedy or method tending to abate fever.

Fever or **pyrexia** is that condition of body in which the temperature is above the normal. It has already been explained (p. 38) that the temperature of the body must not be judged by feeling, but must be accurately measured by a thermometer, and reference should be made to p. 38 for directions as to the taking of the temperature, and the situations in which it may be taken.

THE CAUSE OF FEVER.

The temperature of the body is maintained at a nearly constant level by the action of the nervous system. Heat is always being produced in the body, and heat is always being lost from the body. For a detailed consideration of this subject refer to p. 186, Vol. II. If the same level of temperature is regularly maintained, it is because the heat production and heat loss are regulated to balance one another, and this is effected by the nervous system. We need not stop to inquire here by what means this balance is effected by the nervous system. Details are given on p. 415, and the others already referred to.

Now in fever something occurs to upset the working of the control of temperature by the nervous system. It may be that the heat production in the body is excited to a rate that cannot be equalled by the heat loss in ordinary circumstances; or it may be that the arrangements for promoting heat loss are upset, and that while there is a normal production the loss is far below the normal, so that temperature increases; or it may be the nerve-regulating portion of the mechanism that is disturbed. It may be that all three factors in the maintenance of an even temperature are upset.

Most cases of fever, however, seem to fall under the first and the third of the possibilities stated. For the chief cause of fever is undoubtedly the introduction into the blood and tissues of the body of living organisms, which multiply enormously and produce the phenomena of fever either by their vitality or by the substances which, in their multiplication, they produce.

Fever can be produced experimentally by the injection into the blood of material in which organisms have been grown, but out of which they have all subsequently been removed by filtration. That is to say, though no organisms remain in the material, it contains all the waste products or by-products they produced while they were living and multiplying in it. Such material, injected into the blood, will produce all the chief phenomena of fever. The morbid material circulating in the blood, and coming into contact with the tissues, sets up an exaggerated tissue change, that is an abnormal heat production. This view of fever explains the great rapidity of exhaustion and the rapid loss of flesh in acute fevers, and also the increased quantity of waste products thrown off from the body. Thus in the urine the quantity of urea, which represents the breaking down of certain kinds of tissue, is increased nearly 50 per cent. The remarkable fact that, in some cases of blood-poisoning, the heat of the body has gone on increasing for a time after death, is also explained by this view. It means that though the person has died, the tissues have not all died simultaneously, and the morbid production of heat has continued for a little in some of the tissues.

This explanation of fever would account for the rise of temperature in all cases where the disease is recognized as dependent on an infection, on the introduction into the body of a specific organism or an infusion of its products—toxins as they are called.

Thus we have the class of specific fevers, as they are termed, of which scarlet fever, typhus, and typhoid are types.

The fever of pneumonia, of consumption, of influenza, of sore throat, can readily be ascribed to a similar cause. Indeed, all of these diseases are now ascribed to the operation of one kind of organism or another. All the varieties of blood-poisoning, including child-bed fever, are typical illustrations of the same kind of cause.

PLATE XXVI

PORTION OF A TEMPERATURE CHART IN A CASE OF BLOOD-POISONING (PYÆMIA) WHOSE CAUSE WAS OBSCURE

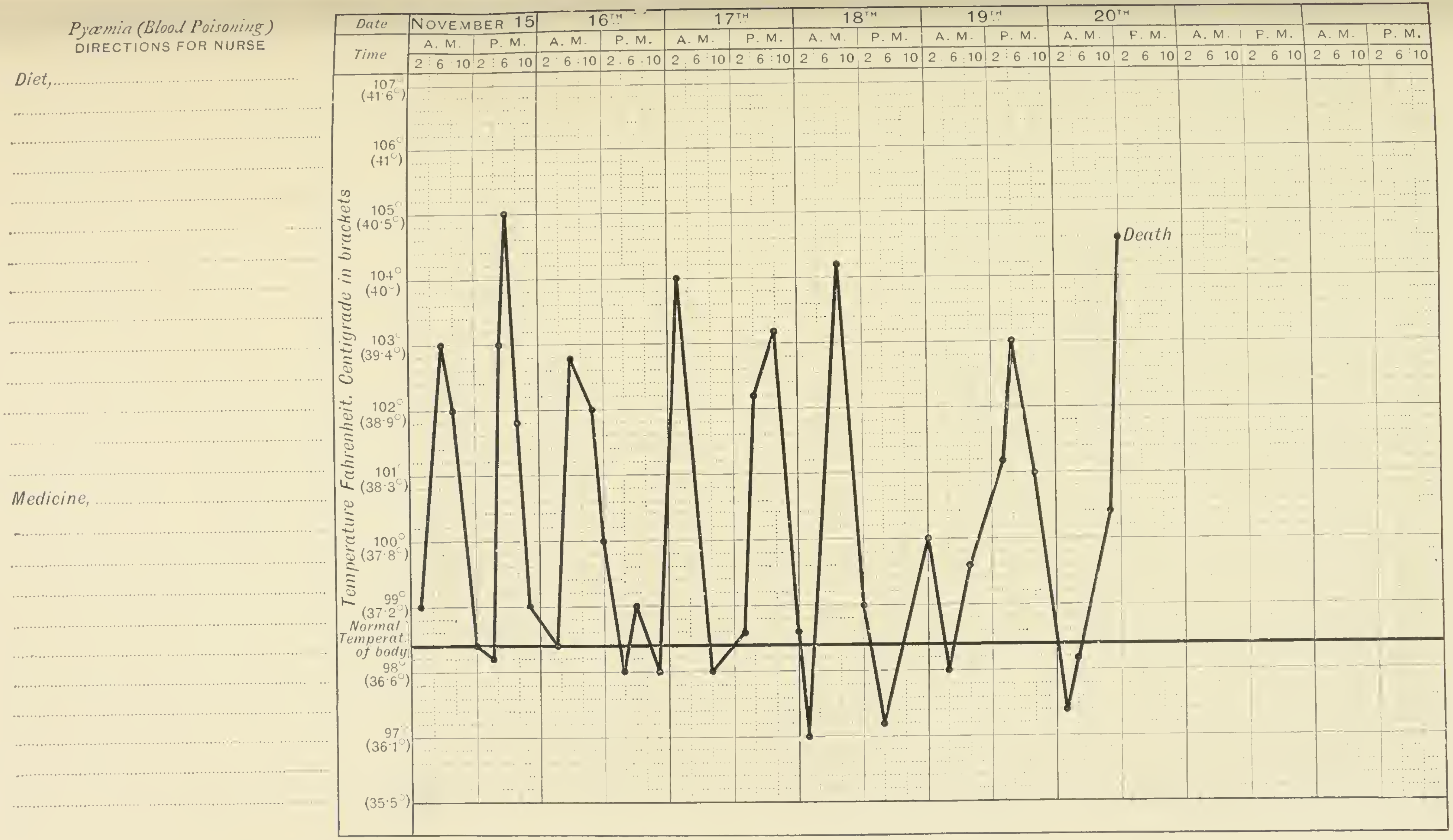
The chart illustrates the extraordinary rapidity with which the temperature may rush up to an alarming height. These rushes occurred, in this case, in spite of vigorous treatment, though at 6 p.m. on the 16th one such rush has been checked, and another at midnight of the 18th. The rushes of temperature recurred, it will be seen, twice in 24 hours.

Each recurrence was accompanied by a rigor, a shivering fit, so severe that the patient's teeth rattled, the bed was shaken, and the patient's skin became livid. The patient looked and felt blue with cold, and yet the temperature was always already high.

The behaviour of the temperature as shown on the chart is significant of the periodical entrance into the blood of some material of a toxic character (see p. 504). Somewhere in the patient's body there was an infective source, an abscess in bone, a suppuration in some recess or cavity or channel, in which organisms were flourishing, and from which their toxic products were gaining entrance to the blood.

Though diligent search was made for the source of infection, it could not be located.

PLATE XXVI



PORTION OF A TEMPERATURE CHART IN A CASE OF BLOOD-POISONING (PYÆMIA)

But there are cases in which, with an ailment strictly limited to a very restricted area, the temperature runs very high. For instance, a small boil in the ear of a child may produce very high temperature for several days. This, too, is an infection, the boil being due to organisms, but it seems more likely that in such a case it is the nervous disturbance that is, in the main, responsible for the high fever. In the case noted, the bursting of the abscess in the ear and discharge of the matter is followed almost immediately by the disappearance of all the symptoms. This is not surprising if we suppose the local disease of the narrow ear passage so disturbed the nervous system as to cause the febrile manifestation, but one would hardly expect the fever to disappear so rapidly if it were due to a general over-production of heat by the tissues, excited by a toxic cause.

We may conclude, then, that fever is in the main due either to an excessive production of heat in the tissues of the body, acted on by morbid material which has gained entrance to the body, or to disorder of the nervous arrangements for regulating temperature produced by the ailment, and that in many cases both of these factors play a part. In cases of the first type the amount of the fever will depend on the quantity or virulence of the morbid material, and to a certain extent will indicate the gravity of the attack. In cases of the second type the height of the fever will depend to a greater extent on the excitability of the nervous system of the individual attacked, and on the situation and sensitiveness of the part which is affected by the ailment. Thus, children, with their unstable nervous system, and women, with their more excitable nervous system, exhibit a higher degree of fever in some ailments than men do. In this second type of cases, therefore, the gravity of the disease is not so well gauged by the height of the fever.

THE OBSERVATION OF THE VARIATIONS OF TEMPERATURE IN FEVER.

All fevers do not behave alike. In any given case of fever the temperature does not always remain at or about the same level throughout the course of the disease. It varies from day to day, and maybe from hour to hour. In nearly all cases there is a period of onset, a period during which the temperature is at its height, and a period of decline. The period of onset is usually indicated by chilliness, or a shivering-fit, a **rigor** as it is called. Even in this stage, when the skin may feel and look cold and even livid, the temperature, if taken by the thermometer, will be found raised. During the period when the fever runs at its height, there are still always oscillations, and the period of decline may be sudden and marked by an outbreak of sweating, diarrhœa, or other circumstances, in which case it is called a **crisis**. In other cases the fever may only gradually loosen its hold, and this is called **lysis**.

Now the temperature in many fevers, and specially the specific fevers, has characteristic modes of onset, has ways peculiar to each special fever of working up to its acme, and, if unimpeded by complications, ends also in typical ways.

The behaviour of the temperature will, then, often be sufficient to indicate the nature of the ailment from which the patient is suffering. In other words, the temperature in many diseases pursues a regular course distinguishing it from temperature due to other causes, and in a few cases the course is so characteristic that the nature of the malady is recognized from it alone, even after only a day or two's observation.

Methodical observation, however, is necessary to distinguish disease thus, and if the temperature, taken at certain regular intervals, be so noted on a chart as to be represented to the eye in the shape of a curve, the recognition of the disease is much more easy.

Temperature Charts.—For the purpose of recording temperatures in a graphic way, charts are prepared which the figures illustrate. These charts may be designed, as that in fig. 201, for recording the morning and evening temperature of each day. In such a case the temperature must be taken at the same hour, say 9 a.m. and 9 p.m. But there may be a two-hourly chart, or three-hourly, or four-hourly, and so on (Plate XXVI.). The two-hour chart may be made to record the temperature each hour by the line dividing off the spaces being utilized. It will be noted that the temperature is marked in the Fahrenheit scale on the left, and on the right the corresponding figures of the Centigrade scale are noted. In the plate the amount of fever according to the latter scale is marked in brackets below the Fahrenheit figures. In each case the level of the normal temperature is marked by a heavy black line from left to right. Above this and below is a fine line corresponding to each increased degree of temperature. Between every two of these lines, marking 1 degree, are four fine lines,

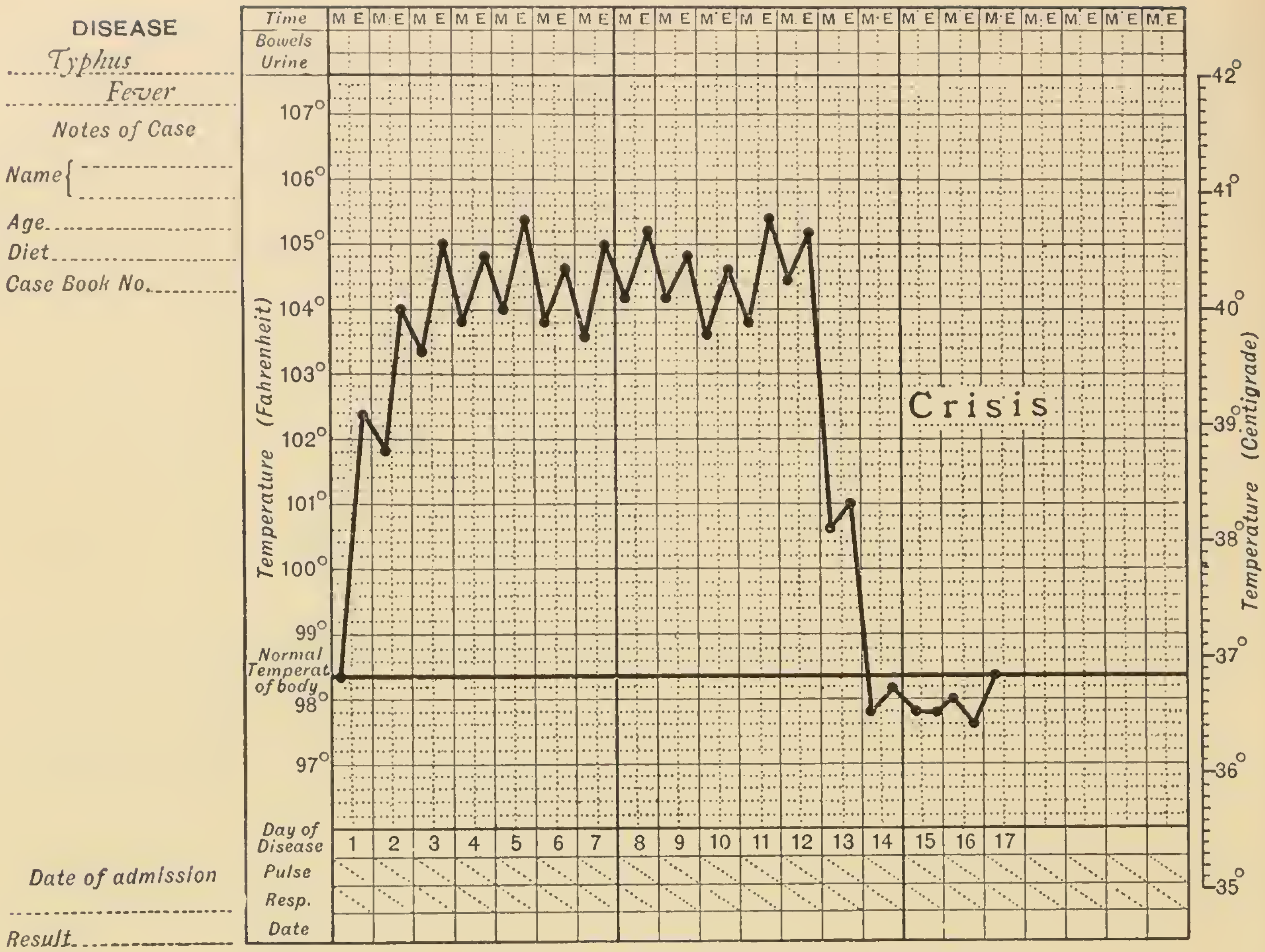


Fig. 201.—Temperature Chart in a case of Typhus Fever, pursuing a normal course.

making five narrow spaces between each degree. Each of these lines, therefore, indicates $\frac{2}{10}$th of a degree, and the space between will indicate half of this, that is $\frac{1}{10}$th or 0·1 of a degree. Thus the heavy black line above 98°, marking the normal temperature, occupies the position of the second fine line above 98°, that is 98$\frac{4}{10}$ths, or 98·4; the space above that will be 98·5°, and the fine line above it 98·6° and so on, till 99° is reached. Then in the chart (Fig. 201) the two spaces headed M. and E., meaning morning and evening, make one day, and every seven of these double columns is marked off by a heavy vertical line, so that weeks are seen at a glance. At the foot of each double column is a space for the date, a space for the day of the disease, and two other spaces for noting pulse and temperature. These last two are divided diagonally to permit more space for the entry of the figures indicating the morning and evening pulse and morning and evening rate of breathing, the upper of the two spaces being in each case used for the morning figure.

A two-hourly chart is shown in Plate XXIX., and it also illustrates how the margin may be used for entering the directions of the doctor to the nurse. This is a portion of an actual chart in a case of typhoid fever fatal because of hæmorrhage.

To understand how the mere graphic record of the course of the fever may help greatly to identify the disease, a chart of the temperature's progress in a typical case of typhus (Fig. 201), and another of typhoid or enteric (Fig. 202), are placed near to one another. That of typhus shows a fever rising rapidly to about its maximum, oscillating there a little, and abruptly coming to an end between the twelfth and fourteenth days, and illustrates the phenomenon of crisis so far as the temperature goes.

Compare this chart with a typical case of typhoid. Note how the temperature mounts by steps, so to speak, each succeeding evening of the first six days being considerably higher, a slight drop occurring each morning, so that by stages the temperature rises for the first week. Note how, during the second week, the temperature maintains an average level, a marked oscillation occurring between morning and evening each day. At the beginning of the third week a descent begins, but like the ascent it is gradual, but in larger oscillations, the morning remission and the evening increase being still marked. This illustrates termination by lysis.

As a contrast to both of these, the chart in a case of blood-poisoning (Plate XXVI.) is introduced. This chart shows the variations of temperature—in some parts hourly—during six

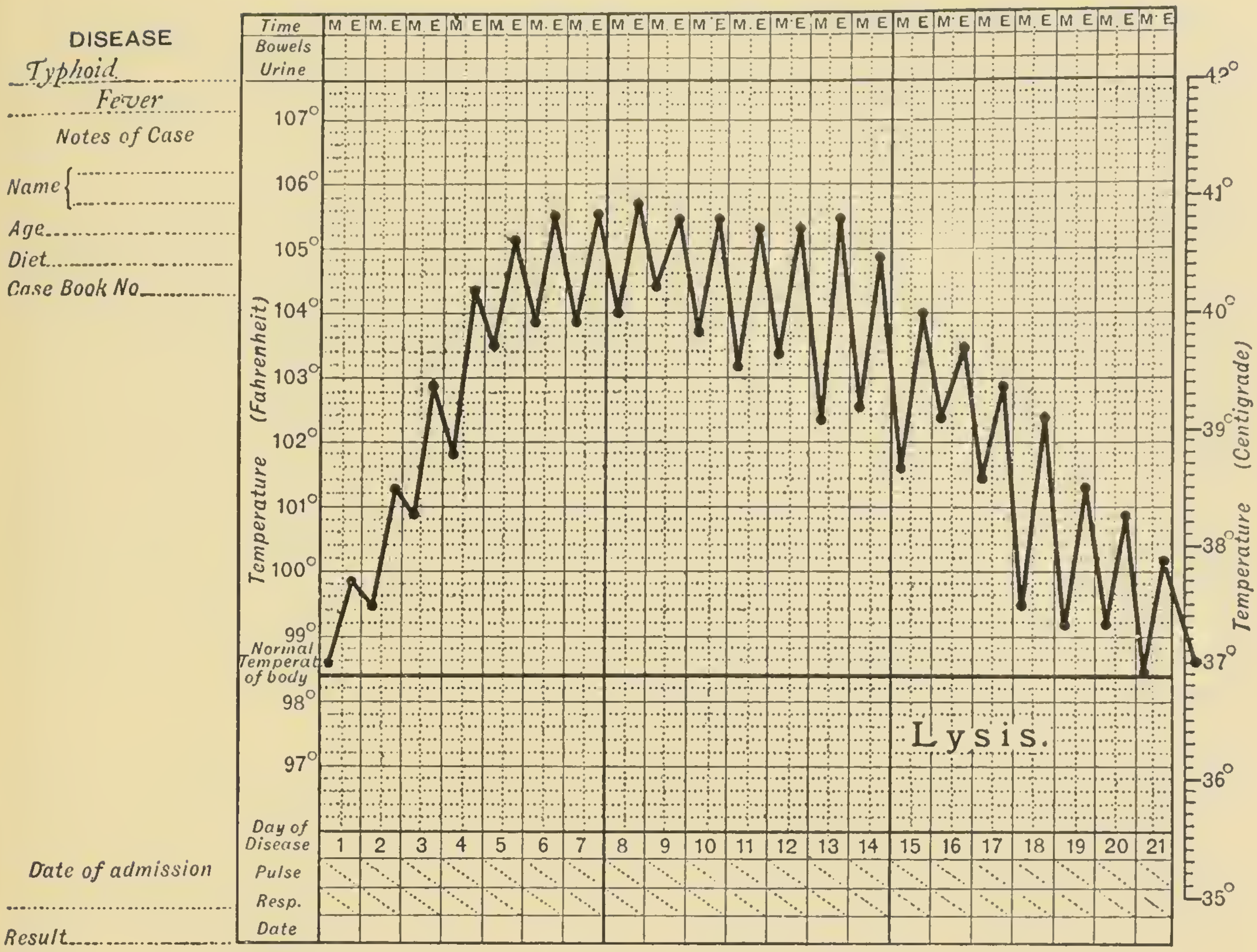


Fig. 202.—Temperature Chart in a case of Typhoid Fever, pursuing a normal course.

days of the disease. Thus on the 15th November, at three in the afternoon, the temperature was 98·2°, and barely three hours later it was 105°, in less than four hours after it had fallen nearly to normal. Day after day this process goes on; between 2 a.m. and 8 p.m. on the 17th two such rushes occurred. This is highly significant of some source in the body, whence, periodically, organisms or their morbid products gain entrance to the blood. For each of these rushes of temperature was announced by a rigor, some so severe that the patient's bed shook, his teeth rattled, his skin became livid, and his extremities cold as death. During all this time the most patient and vigorous treatment availed only to secure the patient a degree of comfort, but nothing was potent enough essentially to alter the fever's own course.

To the experienced eye a glance at Figs. 201 and 202 is enough to suggest the nature of the disease. In the case of typhoid the three first days are sufficient to suggest it before the full development of the other symptoms would permit one to name the disease.

THE TREATMENT OF FEVER.

If what has been said about the cause of increased temperature has been understood, it will be clear that, in most cases, treatment merely to lower the temperature is uncalled for.

The high temperature is merely the evidence of a process going on in the body, of which it is a result. You may alter, diminish, or even abolish the evidence without affecting in the least the thing of which it is only a sign, namely the morbid process going on in the blood and tissues. On the other hand, if you can arrest or modify the ailment, the morbid process, the temperature will immediately subside of itself. If the morbid process has been arrested, or has of itself come to an end, and yet the fever persists, then you may be sure either that you have mistaken the cause of the elevated temperature or have been in error in supposing it had ceased, or that some complication has arisen to continue the febrile condition.

Now, a large number of the diseases accompanied by fever tend to come to an end of themselves at a specified time; all the ordinary infectious fevers do, as well as pneumonia, and other inflammations. It is also true of these diseases that they run a definite course, which cannot be terminated sooner than its own specified time. It is clear, then, that in all such cases the treatment of the disease is the treatment of the temperature as well, in the ordinary and uncomplicated case. It is obvious, therefore, that the first and urgent thing is the settlement of the true nature of the ailment, of which the heightened temperature is only one sign, but possibly the earliest, and it may be, for some days, the only sign. It may, therefore, frequently be a wise thing to let the temperature alone, in order that its behaviour may be observed, and thus the earliest possible indication be obtained of the exact ailment one is dealing with. Parents and friends are often apt to be impatient if some fever mixture or other is not immediately ordered by the physician to check the fever. If they understand what has been written they will perceive that it may be the wisest course, for the patient, not to try to do so. But if so, the physician must have taken every other means open to him to endeavour to settle without delay the true nature of the illness, and he must have given instructions meantime regarding the general management of the patient as to diet, movement of bowels, &c. Only if these conditions are fulfilled can he plead justification for delay in taking other steps. For increased temperature, though commonly only a sign of a disease that will run its own course in spite of any and all interference, is nevertheless occasionally a manifestation of an ailment that can be checked, if dealt with early and vigorously enough. The vital thing, then, we repeat, is to determine the cause of the fever; that being settled, whether active steps should be taken to deal with the temperature itself is easily decided.

In most cases, and certainly in all of the fevers accompanied by eruption, the treatment consists in general measures, chiefly seeing that the patient is comfortably in bed, is kept clean, is placed on simple diet, and that the bowels are moved and the urine duly passed.

It is only when the temperature runs high, and threatens to injure by its mere intensity, when sleeplessness, restlessness, and delirium are marked, that the physician certainly becomes justified in endeavouring to reduce it, and to calm the irritated nervous system. This will be more necessary with some individuals than with others, and it certainly is more frequent with children than with adults. But no routine should be adopted: each individual case should be treated on its merits. In many cases the restlessness, excitement, sleeplessness, &c., seem to depend on the height of the fever, at least to run parallel with it, and the reduction of the temperature is accompanied by calmness and sleep; in other cases the reduction of the temperature does not produce the expected soothing effect, and other measures have to be adopted.

Now the temperature may be reduced in two ways:

(1) By baths,
(2) By medicines (anti-pyretics),

and it will save a good deal of repetition in discussing such treatment under each separate fever if all that need be said be said here.

The Use of Baths in Fever.

The bath may be used in fever for one of two purposes, either (1) for its effect upon the temperature and the excited condition of the patient, or (2) for disinfecting purposes, or for both together. In the former case the bath may be warm or cold, in the second case always warm.

The Warm Bath (temperature 98° Fahr.) is one of the most valuable methods of treatment in infectious fevers in young children, relieving the restlessness and irritability, soothing the irritated skin, and inducing sleep. Care should be taken that the temperature of the water is maintained at 98° by the addition every now and again of hot water to the side. The child should lie, its head supported comfortably, and as quietly as it can be prevailed on to do.

The bath should last 8 to 10 minutes; thereafter the child should be carefully but quickly dried, a woollen or flannel gown put on, and placed in its bed, which has been previously warmed. It should not be tightly tucked in, but just properly covered to maintain comfortable warmth, and loosely rather than tightly, to permit natural invisible perspiration to go on.

Every infectious eruptive fever of childhood may be treated in this way, and in cases such as measles and chicken-pox, where the irritation of skin is frequently intolerable, the relief is most marked.

The Warm Lysol Bath.—In such fevers with rash in children as have been mentioned, the value of the bath is increased by adding a table-spoonful of lysol to the bath of the child's size—say 10 gallons. This not only further soothes the irritated skin, but acts as a disinfectant. There are few cases of such infectious disease in children where such a daily warm lysol bath is not entirely suitable and of great value.

The Hot Pack is given by means of a woollen blanket rung out of very hot water by two persons twisting it, one at each end. On the patient's bed a dry blanket has been spread above the ordinary sheet. The hot blanket is now laid on this, and the patient laid on it, his arms raised. One side of the blanket is now carried over and tucked under the opposite side of the body, and a fold placed between the legs; the arms are then lowered and the other side of the blanket tucked round. The dry blanket is next folded over the hot one, first one side and then the other. In this the patient remains for an hour, getting drinks of cold water and having his face bathed with cold water, after which he is quickly sponged with tepid water, dried, and his bed clothes put on.

The Full Hot Bath is given at a temperature of 95° to begin, gradually raised by the addition of hot water till the temperature is as high as can be comfortably borne. During it the patient may get cold water to drink, and have his face bathed with cold water. The temperature should reach 105° or even 110°, and the bath should last about 20 minutes. When the patient is about to be lifted out, two dry warmed woollen blankets are laid on the bed. On these he is lifted, and wrapped up in them, and allowed to remain sweating for an hour or two, cold water being given him to drink. This is called a **dry pack**. He is then quickly sponged down with tepid water, dried, and his usual bed clothes put on.

These varieties of warm bathing are occasionally useful in fevers, specially in complications of scarlet fever, kidney disease in particular.

The Cold Bath is used in fever for the reduction of temperature, and the symptoms of restlessness, delirium, &c., that occur when the fever runs high. The temperature of the bath must vary with the age and vigour of the patient, and should be somewhere between 65° and 90° Fahr. The typical use of it is in typhoid fever, and it is frequently called the Brand bath, because so vigorously advocated by Ernest Brand of Stettin.

The full detail of the cold bath will be given here, because it is on scrupulous attention to the detail that its safety and usefulness lie.

The bath tub should be a portable one, which can be brought to the bedside, and should be raised as nearly as possible to the level of the patient's bed, but so placed that the nurses have room to lift the patient out and in.

The bath is two-thirds filled with water at the proper temperature.

A stimulant, in the form of a wine-glassful of hot water with two tea-spoonfuls of whisky should be given the patient, and his face bathed with quite cold water. He is then undressed and lifted into the bath. He will gasp and shiver at immersion, but if the nurses just go steadily on, encouraging the patient by a few words, and making as little fuss as possible, the patient is less likely to resist and give trouble than if they coaxed and talked and explained.

The chief thing to watch is the face; blueness appearing is a reason for immediate removal from the bath; but that is not likely to occur, provided the directions be properly followed. The patient's head should be supported by an air-cushion, which one nurse looks after. *Immediately* the patient is immersed the nurses proceed gently to rub every part of the body in succession. This continuous friction is to be maintained all the time the patient is in the water. Two or three times during the bath a basin of water at 50° should be gently poured over the head.

The bath should last 15 minutes.

Meantime someone other than the two administering the bath should prepare the patient's bed.

The bed is first made in the ordinary way. Then a towel is laid to cover the pillow, and a double blanket, previously warmed, is placed on the bed on the side on which the patient is to be laid. On the top of the blanket is placed an old linen sheet, also warmed. Hot bags are placed where the patient's feet will be. The patient is now lifted out and placed on the sheet so that it reaches up to the top of the neck behind, the sheet is brought over his body, first one side and then the other, being made to dip in between arm and body on each side, and the blanket is then wrapped round. By friction with the hands under the blanket the patient is either immediately, or in five minutes, dried by the nurses by means of the sheet; his bed clothing is then replaced, the bed restored to its usual coverings, care being taken that the patient's feet are kept warm by hot bags. Usually there will be little or no shivering, but the patient will be soothed and will fall asleep. This treatment may seem heroic, but those who have employed it assert its entire freedom from risk if given as described, the friction of the patient's whole body being maintained during his immersion.

Anyone wishing to use this bath, and yet afraid, might begin with water at the temperature of 85° Fahr. for ten minutes, and the next time use water at a temperature of 80°. Having thus ascertained how the patient bore it, and having got used to the administration, they might give the next at a temperature of 70°, and only after several trials might the full cold bath at 65° be given for the full fifteen minutes.

The Graduated Cold Bath is another cautious method. The bath is, to begin with, made only one-third full of water at a temperature of 90°. The patient is placed in it, and while one attendant maintains friction, another gradually adds water at 40°, round the sides, till the temperature of the bath is reduced to 75°. In this case the bath should be prolonged to nearly half an hour.

The Cold Pack is another method for reducing temperature. On a bed prepared in the ordinary way a rubber sheet is spread. On this is laid a woollen blanket, long enough to extend from the back of the patient's head to half a yard or so beyond his feet, and so placed that one-third hangs over the left side of the bed. A large coarse linen sheet is now wrung out of water of a temperature from 60° to 70°, according to the case, and laid on the blanket, and on this the patient is placed naked. The patient raises his arms above his head, and the right side of the sheet is carried over his body, close up under the arm-pits, to the left side, where it is tucked in under the side, the lower portion being so arranged as to dip between the legs. The arms are now placed close to the sides against the sheet, and the left side of the sheet is carried over the body, arms included, close under the chin, and tucked in under the whole length of the right side. The left side of the blanket is now carried over the body and tucked in under the right side, and then the right side is carried over in a similar manner and tucked in under the left side of the body, and close round the neck under the chin. At the feet the blanket is folded over. A wet towel is now fitted to the patient's head, like a turban, and then several woollen blankets are placed over him.

For some time the patient feels chilly, a time depending upon his own power of reaction, usually 5 to 15 minutes. Thereafter he becomes comfortable, feels the soothing effect, and is usually unwilling to be disturbed sooner than three-quarters of an hour to an hour.

When the pack is used to reduce temperature, as soon as it has become warm, the patient should be removed from it, and rewrapped in a fresh one, the sheet for which has been wrung out of water 2° higher than the first. If there are two beds in the room, the second pack may be ready and the patient removed from the first to be wrapped in the second. Meantime a third pack is to be prepared, to which the patient is to be transferred as soon as the second has become warm, which is likely to be about 10 minutes, the third pack being prepared with water 2° higher than the second. This process is repeated till the temperature has been reduced to nearly normal. This method has the advantage that the process may be stopped or gone on with according to the indications derived from the condition of the patient. It will require usually four or five such packs to reduce the temperature, and when the patient is removed from the last, his whole body should be rapidly sponged with water about 55°, dried, and his bed-clothing put on.

Cold Sponging is a still milder method of reducing temperature, and is very applicable to children or old or feeble persons. A rubber sheet covered with a blanket, and then with an old linen sheet, is pushed under the patient, whose clothing has been removed. It should be so adjusted that it hangs on one side, when the patient is lying, over the edge of the bed, and on the other side the spare portion is rolled up lengthways. A blanket covers the patient. To the bedside there are brought a large basin filled with water at a temperature of 65°, a sponge, sponge-cloth, or large piece of gauze, and several old linen towels, or portions of sheets.

One part of the body after the other is exposed, bathed with the water, dried, and covered. One begins with the face. Then an arm is exposed, water is taken up in the hollow of the hand from the basin, dashed on the arm, and then with the fingers the arm is gently rubbed, more water is dashed on, more friction applied; then the arm is dried and covered, or a dry towel is wrapped round it, it is covered with the blanket, and the same process is applied to the other arm. That being done and covered, the chest is next exposed and similarly treated, then the back, next one leg and then the other, but the feet and hands are not wet with the cold water.

Another method is, when the part of the body to be treated is exposed, a thin linen towel without fringes is lightly wrung out of the water and laid over the part, and water thrown upon it from the hand, friction and patting being employed, over the linen cloth.

The whole body is gone over as rapidly as possible, and either each part is dried at the time or wrapped in the towel, till the other parts are done. Finally the whole body is dried and reclothed.

The height of the temperature, the strength of the patient, and the effect produced on the first application will determine the exact temperature at which the water should be used, and the duration of the process.

For in a fever of any duration such a process will, in all probability, have to be employed frequently, perhaps even several times a day, to keep the temperature under control. An intelligent attendant, beginning with the cold sponging, ought quietly to ascertain what the patient needs and can bear, and may from it acquire confidence to go on to the full cold pack, or even the full cold bath.

Remedies for Fever.

In the main, during fever, medicines are given—

(1) To act on the bowels;
(2) To make the skin act, and so relieve its hot, dry, burning character, and thus lower the temperature;
(3) To stimulate the kidneys, and increase the flow of urine;
(4) Directly to reduce high temperature;
(5) To diminish excitement and induce sleep.

1. The bowels should always be acted on at the outset by a good clearing-out dose of medicine. For this castor-oil is best, though, to those who strongly object to it, ½ to 1 teaspoonful Gregory's mixture may be given, or compound liquorice powder (½ to 1 teaspoonful), or any of the bitter waters, Apenta, Hunyadi Janos, Rubinat, or Franz Joseph. Subsequently, as required, one of the mineral waters is best; or fruit salts or saline will be found agreeable, given in cold water, and flavoured, and to children fluid magnesia.

2. The skin is best acted on by one variety or other of bath: the warm bath for children, or cold sponge, the cold pack or bath for adults. But if medicine is insisted on, or for one reason or another is more easily used than the bath, the following mixture may be given:—

Liq. acetate of ammonia, ...	4 ounces.
Simple syrup, ...	2 ,,
Water,..	2 ,,

Half a tea-spoonful to children, a dessert-spoonful to adults in a table-spoonful of water may be repeated every two hours till the effect is obtained.

3. To stimulate the kidneys pure water is best, and it may be given in wine-glassful doses, flavoured with a few drops of lemon, every hour till the urine is increased, clearer and less highly coloured. If some medicine is deemed necessary, the sweet spirit of nitre (spirit of nitrous ether) is the best, 5 to 10 drops for a child, 30 drops for an adult, and it would be well to give it added to the above mixture. If the two were made up together it would be thus:—

Liq. acetate of ammonia, ...	4 ounces.
Spirit of nitrous ether,...............	1½ ,,
Syrup and water, ...to	8 ,,

Half a tea-spoonful to a child, a dessert-spoonful to an adult, given in water and repeated till the effect is produced.

4. To reduce fever, as has been said, one form or other of bath is best. The medicine most likely to succeed is antipyrin. It also is best given in repeated small doses at short intervals till the effect is produced, and it is well to combine it with the ammonia mixture, but the ether must be left out, as it forms a bad combination with antipyrin. The mixture would then be:—

Antipyrin,..............................	320 grains.
Liquor acetate of ammonia,......	4 ounces.
Syrup and water,.................to	8 ,,

Half a tea-spoonful to a child, a dessert-spoonful to an adult, given in any desired quantity of water every two hours till the temperature is down to 100°.

Any intelligent attendant, who can watch the temperature by means of the thermometer, will soon discover how frequently the mixture must be given to keep the fever within reasonable bounds. It is not a good way to let the fever have its swing till it gets alarmingly high. But as soon as it is apparent that something must be done to keep it within bounds, then it is the business of the nurse to set herself to find, not how she and the fever may play battledore and shuttlecock, but to discover how much is needful of cold sponging, or cold pack, or cold bath to keep the temperature from going above 102°. If these means are not available, and she can get the medicine, then she sets herself to repeat the dose till the temperature is down to 100°, as has been said, and after that to find how much, and given how often, is just sufficient, and no more, to keep the temperature from rushing above 102°.

5. Restlessness, delirium, and sleeplessness are not the result of the high temperature alone; they are partly the result of the high temperature, but in part directly due to the poisons circulating in the blood and acting on the nervous system. Nevertheless the height of the temperature also, as a rule, marks the greatest degree of these symptoms also, and the reduction of the temperature will to some degree allay them. The bath is here again to be preferred, but where medicine is desired the ammonia and antipyrin mixture is the best, just as it is for the fever. But where restlessness and delirium are specially marked and troublesome, a little bromide of potassium may be added to the mixture, which then becomes—

Antipyrin	320 grains.
Bromide of potassium	1 ounce.
Liquor acetate of ammonia ...	4 ounces.
Syrup and water, to	8 ounces.

Half a tea-spoonful as before to a child, a dessert-spoonful to an adult, given in any desired quantity of water, and repeated every two hours till the desired effect is obtained.[1]

CONVALESCENCE.

This is the period during which, the disease having ceased, the patient's disturbed organs gradually return to the state of health, and his strength gradually becomes restored.

All the febrile medicines are, of course, by this time stopped, and only aperient medicine is occasionally given.

It is a time when the attendant must exercise a great deal of reasonable but firm control over the patient, restraining alike his peevishness and his haste to be up. The patient usually wants to hurry, to get some change of diet, to be allowed to sit up, to see friends, to get out of bed; the nurse should hurry slowly.

It is a good rule to give no change of diet, that is, to give nothing beyond milk, light soups, light milk-puddings, bread and butter, till the coating is quite off the tongue and it is perfectly clean. Then a light solid meal of fish, or chicken, with a little tender vegetable, &c., may be given to dinner, and this, after a day or two of trial, agreeing, additions may gradually be made to other meals.

As regards sitting up, another good rule is “one thing at a time”. If the patient is getting a change of diet, which may tax his newly restored digestive power, it would be a mistake simultaneously to tax his other powers. So give him his choice, a continuance of the simple diet, and a short trial out of bed, or a gradual variation of diet, and no getting out of bed till the success of that experiment is proved. Probably, however, he can be allowed to sit up in bed to meals. After several days of varied diet, without disturbance, then he may be allowed up at the bedside for a few minutes. A very few minutes will likely suffice, for most frequently a patient feels giddy and even faint at first. This is just because his blood-vessels, unused for a time to the vertical position, dilate with the pressure of blood, the blood deserts the vessels of the head, and the patient looks white and feels faint. This will gradually cease with custom. It is better for the patient to be up a short time twice daily than to be up only once and a longer time. The patient should quite have regained his steadiness before he is allowed to venture out, and as soon as he is fit to get out he is fit to get away for a change, the best way to complete his restoration.

Of course, the first time he leaves his room it must be for a disinfecting bath, and to be clothed in fresh non-infected garments; and he must then not return to that room till it has been thoroughly disinfected.

After the patient has become fit for a varied diet, and not before, tonics, either for digestion, or of quinine and iron, may be resorted to, if desired. But change of air will do more than any of these.

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[1] It may be noted that this means: to a child 2½ grains antipyrin, 3¾ grains bromide; to an adult 10 grains antipyrin, 15 grains bromide.

IMMUNITY.

Natural Immunity.—This is the term used to imply that a person has a degree of insusceptibility to any disease. We all know people who are very susceptible to any disease they come in contact with, and in some cases the susceptibility is a characteristic of a family. Sometimes it is to one kind of disease, infectious disease in particular, sometimes it is a general susceptibility. In the same way there are persons who have a more marked power than ordinary of resisting disease, whom epidemics leave untouched. These people are said to be immune, or to have immunity, and, just like susceptibility, it may be an individual or a family characteristic, and may apply to certain types of disease or to disease in general. There are diseases, also, which attack animals, to which men are not prone, and similarly there are diseases of human beings which do not naturally attack animals; for instance, typhoid fever and cholera do not attack the lower animals. That is to say, human beings are immune to some diseases to which animals are prone, and *vice versa.*

Acquired Immunity.—It is a familiar fact that, in the case of most of the infectious diseases, one attack protects against another, more or less completely; that is to say, by the one attack the person has become immune to the disease; immunity, that is to say, has been acquired. This was always a striking fact in the observation of disease, and reference to the paragraphs on small-pox will show how it was made use of in order to protect from the grave form of that disease, multitudes being, at risk of life, deliberately inoculated with the disease, which, introduced in this way, ran a milder and less disfiguring course, rather than incur the risk of taking it in the ordinary way.

But it was not till it became clear that infectious diseases were due to the introduction into the body of living organisms, and were the expression of the growth and multiplication of these organisms in the body, that the full significance of the fact of acquired immunity became apparent. For, if each infectious disease were due to one special organism, if the symptoms of the disease were due to the changes going on in the body by its growth, if one attack of the disease protected against a second, and if the organism could be separated and grown pure outside the body, there was an obvious possibility of producing the changes in the body on which immunity depended, with less risk and in shorter time, by the use of the artificially reared organisms. It has already been explained (p. 501) how this idea occurred to Pasteur, and how the possibility was converted by his experimental genius into certainty in the case of anthrax.

Artificial Immunity is the proper term to use when an animal or person has been protected in the way indicated in the last paragraph from an attack of a particular infection. Up to a comparatively recent time, vaccination against small-pox was the only kind of artificial immunity practised on the human being. In animals, on the other hand, the possibility of artificially conferring protection has been proved in quite a number of diseases.

It has been pointed out (p. 504) that the phenomena of fever may be due—

(1) Either to the growth and multiplication of the organism of the disease in the blood and tissues of the person attacked, or

(2) To the poisonous action of the chemical substances produced by the organisms, or

(3) Partly to one and partly to the other.

It has been proved, for instance, that in some diseases all the symptoms can be produced by the introduction into the body of the material in which the organism has been grown, but from which all organisms have been removed by filtration. Such a liquid would contain all the soluble poisons produced by the agency of the organism in the fluid in which it was cultivated, but none of the organisms. This is true of diphtheria and tetanus (lock-jaw). In such diseases, therefore, it is not so much the mere growth and multiplication of the organisms in the body that produce the features of the disease as the poisons (toxins) which they manufacture, and which are circulated with the blood, poisoning the tissues. In other diseases, of which tuberculosis is an example, the introduction of the toxins may produce symptoms, but not the characteristic developments, of the disease, the living organism being necessary for that.

Immunity in a person or animal must, therefore, in most cases, mean two things. It must certainly mean, in the first place, that the tissues and blood have been made somehow incapable of affording the material for the growth and multiplication of the organism; for if the organism could grow, its toxins would be produced. And in the second place, it may mean that the toxins, though they gain entrance to the blood, are somehow antagonized, so that they produce no harm.

Now experiment has proved that both these results can be artificially produced in men and animals.

Of course, before this can be done for any particular disease, it is necessary that the organism which produces that disease should be known and be capable of artificial cultivation.

It has been shown, practically of all such organisms, that they can be cultivated under such conditions as will either diminish or increase their virulence, as may be desired. Thus varying strengths of the organism can be reared, and, beginning with a weak strain, they are injected, at proper intervals of gradually increasing strengths, into the animal or person to be made immune. Just as a mild attack of scarlet fever protects, at least for a time, from a virulent attack, so the weak organism protects the body from the subsequent stronger dose; each succeeding injection, therefore, confers a greater immunity, until complete insusceptibility is produced.

In the same way the organism may be reared in broth, and then the broth filtered. It contains in solution not the organisms but the toxins. These also may be made weak or strong, and then repeated injections, beginning with small doses or doses of weak strength, gradually render the person or animal insusceptible to the toxin. This method is successful not only against diphtheria and tetanus, but also against snake poisons.

An animal or person made insusceptible in either of these two ways is said to be **actively immune**, that is, they resist an attack of the disease by reason of the quality imparted by the injections to their own tissues and blood.

Antitoxic Serum.—But in the course of the many observations and experiments made on this subject, a still more remarkable fact became apparent, the fact, namely, that the blood of one animal, made insusceptible in one or other of these ways to a particular infection, could protect another animal from attack, into whose body it was injected. This second animal is said to be **passively immune**, that is, it is not insusceptible on account of the resistance of its own blood and tissues, but in virtue of the immunized blood of another animal injected into it. In such a case it is not the whole blood that is used. Some blood is withdrawn from the body of the animal made actively immune, and under precautions allowed to stand. The blood separates by coagulation into clot and serum (see p. 294). The serum is drawn off, and, to preserve it, mixed with a small proportion of carbolic acid or such preserving agent, and then kept in sealed bottles. This serum, injected into another animal or into a person's body, will render that animal or person insusceptible to the attack of the particular infection. There are now highly scientific and accurate methods of estimating and regulating the strength of such sera, so that the amount required to be injected in any particular case can be judged. The animal whose blood is made the medium of preparing such sera is none the worse of the process. Indeed, if it were not kept in a condition of excellent health it would not be suitable for the purpose, and the amount of blood withdrawn from it at intervals is so regulated as to do it no injury.

The sera so prepared at present in use are the serum against diphtheria, that against tetanus, that against blood-poisoning (whose organism is the streptococcus), that against hydrophobia (rabies), that against plague, that against snake poison; or the

Anti-diphtheritic serum,
Anti-tetanic ,,
Anti-streptococcic ,,
Anti-rabic ,,
Anti-plague ,,
Anti-venene ,,

and they are all classed as antitoxic sera. It is to be noted that these are neither preparations of the organisms nor of their poisons, they consist of the fluid of the blood of an animal immune to the organisms' attack. In the case of the anti-diphtheritic serum the animal used is the horse.

One great distinction must be noticed between the active immunity gained by injecting gradually increasing strengths of a culture of the organisms of a disease into a person's body, or a solution of the toxins, and the passive immunity gained by injecting the serum of a highly immunized animal; this, namely, that the first process takes some time, while the second process is practically immediate. If a person had already been infected by a disease, there would not be time to make him insusceptible by the former method before the disease developed, while the use of a serum has immediate effect in preventing the development of the disease. The antitoxic sera are, therefore, curative agents, if used soon enough after infection, while the methods of producing active immunity are only preventive. Of the latter method Haffkine's inoculation against cholera, and Wright's against typhoid, are excellent illustrations, while vaccination illustrates a method both preventive and, if used early enough—within four days of infection,—also curative.

There is evidence that the blood of a human being recovered from typhoid fever or cholera can confer immunity, and not the blood only, but some of the secretions, such as milk, and there are reasons for believing that in this way the milk of a nursing mother may render her child insusceptible to the infectious disease from which the mother has suffered.

Phagocytosis.—It is one thing to state the facts of immunity, as has been done; it is another to attempt any explanation of them. For numerous theories have been advanced, and the subject remains yet incapable of decision. But, for the sake of anyone interested in this subject, it is necessary at least to mention the theory of Metchnikoff, one of the most distinguished investigators of the Pasteur Institute of Paris. In the description of the blood, pp. 19, 293, the varieties of white cells found in it have been stated. It is the business of certain of these white cells, according to Metchnikoff, to defend the body against the attack of any invading organism. If some organism gains entrance to the body by a wound, or other breach of surface, an inflammatory reaction takes place round that spot. There is a rush of blood to the part, and some of the cellular elements of the blood, specially the white cells, escape from the blood-vessels, and are found in large numbers round the wound (see p. 328). According to Metchnikoff these white cells attack the invading organism, taking them into their substance and digesting them. If the body resists the attack, it is because the invading organism is eaten up by the white cells, which have been, on that account, called **phagocytes** (refer to p. 330). If the body fails to resist the disease, it is because the organisms have been too numerous or too active to be thus disposed of by the phagocytes. This method of defence is called **phagocytosis.** Immunity, according to this view, depends on the activity and vigour of certain of the white cells of the blood, aided by connective tissue and other cells.

DISINFECTION.

It has been shown that infectious diseases are communicated from a sick person to a healthy person by material thrown off from the body of the sick person, the active part of the material being probably some form of living organism. It has been seen that the poisonous material may come off from the patient's body in his breath, in discharges from the mouth and throat, from the skin, from the bowels, and from the kidneys. It is desirable that as soon as possible all poisonous material should be destroyed in one way or another to prevent the spread of the disease. All the means employed to accomplish this are included under the term disinfection, and the materials that may be used for the purpose are called disinfectants.

Disinfectants commonly used are carbolic acid, chloride of lime, Condy's fluid (which the proprietors prepare according to their own method), sulphurous acid, obtained from burning sulphur, Burnet's fluid (a solution of chloride of zinc), sulphate of copper (blue vitriol) dissolved in water, and sulphate of iron (copperas), sulphuric acid (oil of vitriol), and hydrochloric acid (spirit of salt). These substances ought to be used in such a way as to destroy the matter of contagion.

Antiseptics.—There are some substances which, strictly speaking, do not destroy the contagious matter, but simply prevent its growth and multiplication. These are called **antiseptics**; and a good example is carbolic acid in weak solutions. The living matter of contagion cannot multiply when exposed to the action of an antiseptic, but if the antiseptic be removed the contagion may then go on to multiply. Its growth is merely *arrested for the time being*—the living organisms are not killed.

Deodorants.—There is another class of substances which may remove the offensive smell of decaying matter without killing or hindering the growth of contagion in it. These are **deodorants**. It is a true disinfecting action that is wanted, an action which will kill the contagion, so that neither at the moment nor at any future time can it become capable of doing harm.

TO DISINFECT A PATIENT'S BODY.

The patient should be kept perfectly clean. His body should be sponged daily with lukewarm water, to which a small quantity of ordinary vinegar (acetic acid) may be added. When scales or crusts are separating from the skin, the body should also be daily anointed with lard, or with olive-oil or glycerine, with every 40 ounces of which 1 ounce of pure carbolic acid should be mixed. This prevents the scales, &c., being scattered about in the air of the room, and at the same time acts as a disinfectant.

TO DISINFECT NURSES' OR OTHER ATTENDANTS' HANDS.

The best method is washing in water made pink with Condy's red fluid, or with the permanganate of potash, or in water in every 2 pints of which 1½ ounce of carbolic acid has been dissolved. *All dirt should be removed from under the nails in the process of washing.*

TO DISINFECT CLOTHES.

They should, immediately on removal from the patient, be steeped for at least an hour in water, every gallon of which contains a quarter of a pint of carbolic acid. The acid is, however, dear; in its place water containing 2 ounces of chloride of lime to the gallon (1 pound to 8 gallons) may be used, and has the merit of cheapness. Care must be taken that only the clear water is used, containing no particles of the lime, which would burn the clothing. To prevent this a wooden tubful of the solution should be made at a time. The chloride of lime should be well stirred with a stick and then left to settle. After it has quite settled, the clear liquid from the top can be drawn off as required. After steeping, the clothes should be washed and boiled. Rags and scraps, not to be kept, should be immediately burnt. Articles of clothing that cannot be so steeped and washed, beds, &c., should be exposed to the fumes of sulphur, applied as directed for disinfecting rooms.

TO DISINFECT DISCHARGES FROM THE BOWEL, &c.

They should be passed into vessels already containing a disinfectant solution. A cheap one is made by chloride of lime, 1 pound to the gallon of water. A stock of it should be kept, and some placed in each vessel as required. For the same purpose water, containing oil of vitriol (sulphuric acid), in the strength of 1 ounce of acid to 1 gallon of water, may be employed. A mixture used for the same purpose is made of 8 ounces of sulphate of zinc (white vitriol), 1 ounce of carbolic acid, and 3 gallons of water. On the whole, the chloride of lime is as useful as any, and very cheap. Plenty of the disinfectant should be mixed with the discharge. When the whole has been emptied into a water-closet the basin should be well flushed with water to prevent the disinfectant collecting in the pipes and eating through them. If there is no water-closet—if, for instance, a dry closet is in use, as in the country—the discharge should be received in a vessel containing a solution of oil of vitriol or spirit of salt (of the strength of 1 ounce to 20 of water); chloride of lime should be added, and the whole thrown into a pit in the ground far from all wells or other water-supply, and fresh earth thrown upon it. All chamber vessels should be washed in an acid solution, water containing 1 ounce of oil of vitriol, or spirit of salt, to the gallon.

TO DISINFECT ROOMS.

To disinfect rooms, sulphur or chloride of lime should be used. Windows must be tightly closed, fireplaces and all crevices and cracks properly blocked up. Articles of clothing, bedding, &c., should be hung on lines. An iron vessel is placed in the middle of the room, containing 1 pound or more of sulphur, according to the size of the room (1 pound for every 1000 cubic feet of space), and, when everything is ready, the sulphur is to be lighted by placing a live coal on it. The door is then tightly closed and left so for 24 hours. Thereafter windows and doors are opened; and the room is freely ventilated for other 24 hours. After this has been done the ceiling should be whitewashed and the walls washed down. If the walls are papered, the paper should be washed off and burnt. Wood-work should be washed with water and soft soap. If chloride of lime be used it should be placed in a large shallow dish, and sulphuric acid, diluted with water, poured upon it. The rest of the procedure is the same as described. It is to be noted that the chlorine gas will remove the colour from coloured stuffs.

HEAT AS A DISINFECTANT.

The best way of disinfecting beds, bedding, and articles of clothing that cannot be washed easily is to expose them in a hot-air chamber for two hours or more to a heat ranging between 210° and 250° Fahr.

If, however, all clothes of every description were plunged, immediately on removal from the patient, even before passing from his room, into tubs containing water and ordinary washing soda, and so carried from the patient's room, allowed to steep, and then washed and boiled, the risk of communicating disease by them would be practically destroyed.

TO PREVENT THE SPREAD OF INFECTION.

The following rules should be adopted in infectious disease to prevent infection spreading:—

1. Place the patient in a room by himself, from which carpets, curtains, and hangings of every description, including pictures, &c., have been removed. All furniture, except a wooden table and chair, should also be removed. The room should be well ventilated. This is best done by keeping a fire always burning in the grate. The floor should be kept clean, being done in small portions at a time, not all at once. The door should be kept closed, and a sheet should hang outside it, and be sprinkled daily with the Condy's fluid or carbolic acid solution.

2. Let none come near the room except the nurse and medical attendant. The nurse should wear some dress that will wash. She should keep her hands clean by washing, as noted above. When she must attend to other household duties, she should take off her dress before leaving the room and put on another kept hanging outside for the purpose. She should mix as little as possible with other members of the household.

3. All cups, plates, and utensils used by the patient should be passed through a solution of chloride of lime (2 ounces to the gallon of water) immediately on being taken from him, and afterwards washed in boiling water.

4. All towels, handkerchiefs, clothes, &c., used in the room should be steeped in the weak chloride of lime or carbolic acid solution.

5. All the patient's discharges, spit, vomit, discharges from bowels, &c., should be treated as noted on p. 516. Remains of food and drink should be similarly treated and thrown out.

6. The patient should be kept clean, as directed on p. 516.

7. On recovery, and before mixing with other members of the household, the patient should be bathed and clothed in a completely fresh set of clothing, which clothing must not have been kept in the sick-room.

8. After the removal of the patient, the room and all articles of clothing left in it should be disinfected, as directed on p. 516.

9. The house should be kept clean and well ventilated during the sickness, the water-closets being specially attended to.

10. Should the patient have died, it is desirable to disinfect the body by wrapping it in sheets wet with carbolic acid solution (1 ounce of acid to 20 of water), or chloride of lime solution (1 ounce to 40 of water); and sawdust soaked in either of these solutions may be placed in the coffin.

If these rules seem troublesome to follow out, it should be remembered that the duty to the healthy is not less than to the sick; and where they are neglected, and infection spreads, the moral guilt resting on those who have been neglectful is great.

Duration of Quarantine, Duration of Isolation, and Time for Disinfection in Infectious Diseases.

If a child has come into contact with an infectious disease, it should not return to school till it is certain that it has not caught the infection, for then it would become an active agent in the spread of the disease. The child must, therefore, be kept from mixing with other children at school *or at play* till sufficient time has elapsed, since it was exposed to infection, to permit the disease to develop, if it is going to do so. This time varies with the disease, being determined by the incubation period of the disease. This time is called the **period of quarantine**, and should be two days longer than the incubation period of the disease. But it must be noted that before one begins to count the time, one must secure that the child is removed from the source of infection, and that its clothes are disinfected. Thus, suppose two brothers, of whom one develops scarlet fever, and the two have been sleeping together till it became known that one had scarlet fever. One cannot begin to count the quarantine time of the other brother till he has been removed from the infected house and has been disinfected. After that one waits ten days, and if he shows no signs of illness, and has remained away from the infected house, he may return to school. If, while quarantine period is running, a child again comes in contact with infection, it must be removed, again disinfected, and quarantine must begin over again.

The sick child must be separated from others, and must be so kept apart that the infectious material being produced in, and given off from, his body cannot reach others, and he must be kept apart as long as such infectious material is being produced. The infectious period begins earlier in some diseases than in others, and lasts longer in some than in others, and so the period during which the child must be kept apart varies with each infection, and is called the **period of isolation.**

When the child has ceased to produce infectious material in his body, then he must be disinfected before being permitted to mix with others, that is, any infectious material clinging to skin, hair, nails, clothing, &c., must be removed or destroyed.

The following table[1] shows the period of quarantine, duration of isolation, and earliest date of disinfection in the common infections:—

Name of Disease.	Period of Quarantine. It begins when the person has been removed from the source of infection and has been disinfected, and it continues for—	Duration of Isolation (indicating the Earliest Date for Disinfection).
Measles.	16 days.	14 days from day of appearance of rash.
German Measles.	20 days.	10 days from day of appearance of rash.
Scarlet Fever.	10 days.	Not less than 6 weeks from date of appearance of rash, provided skin has all separated from hands and feet.
Chicken-pox.	20 days.	Till every scab has fallen.
Small-pox.	16 days.	Till every scab has fallen and till skin is all healed.
Mumps. See p. 153.	24 days.	Three weeks from commencement; longer if all swelling has not subsided.
Diphtheria.	12 days.	Not less than 4 weeks; longer if sore throat remains or there is any discharge from nose.
Whooping-cough.	21 days.	At least 5 weeks from commencement of whoop, or until spasmodic cough and whoop have been absent for 2 weeks.

INFECTIOUS FEVERS ATTENDED BY RASH (ERUPTION).

GENERAL CHARACTERS.

Fevers accompanied by eruptions (rashes) on the skin were classed by the old authority, Cullen, as **exanthemata.** This term is derived from two Greek words, *ex*, out, and *antheo*, to blossom. The phrase **exanthematous fevers** includes all the fevers, attended by a rash, which are described under the above heading. They have several characters in common.

1. They are all due to the introduction into the body of some special material whose growth in the body is attended by the progress of the disease. They are all contagious or "catching".

2. The fever does not show itself till some time after the poison has obtained entrance into the body. There is an interval, that is to say, between the time the person becomes infected and the time he actually becomes fevered. This interval is called **the period of incubation** or **hatching.**

3. The fever lasts a definite time, and runs a certain course in each case.

4. The disease is accompanied by a rash, of a special kind for each fever, which goes through a regular series of changes, and disappears at a definite time.

5. Each fever ends at a certain time, in some cases suddenly after copious sweating or loose motions of the bowels, in other cases gradually. In the former cases it is said to end by **crisis** (Greek, *krisis*, a decision or turn); in the latter

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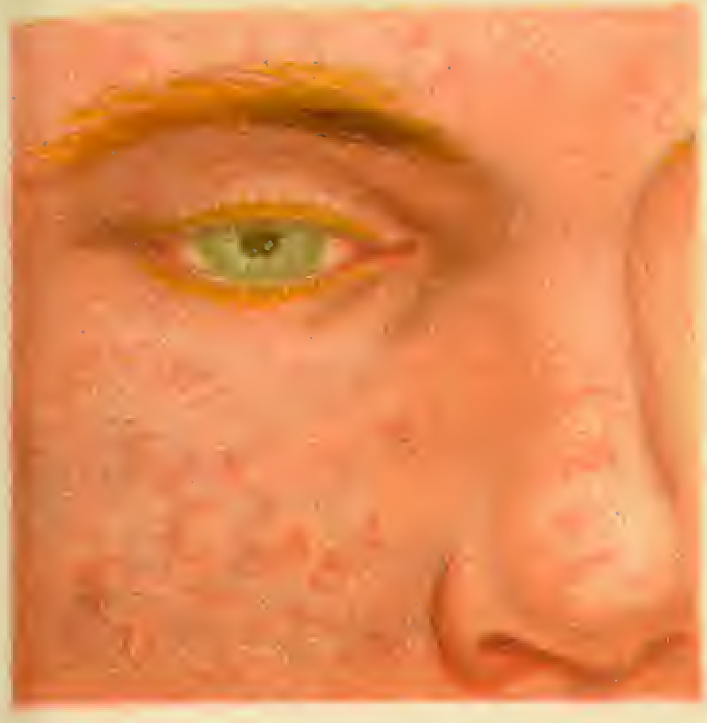
[1] As different authorities give different times, I have taken the Code of Rules of the Medical Officers of Schools Association of the English Public Schools.

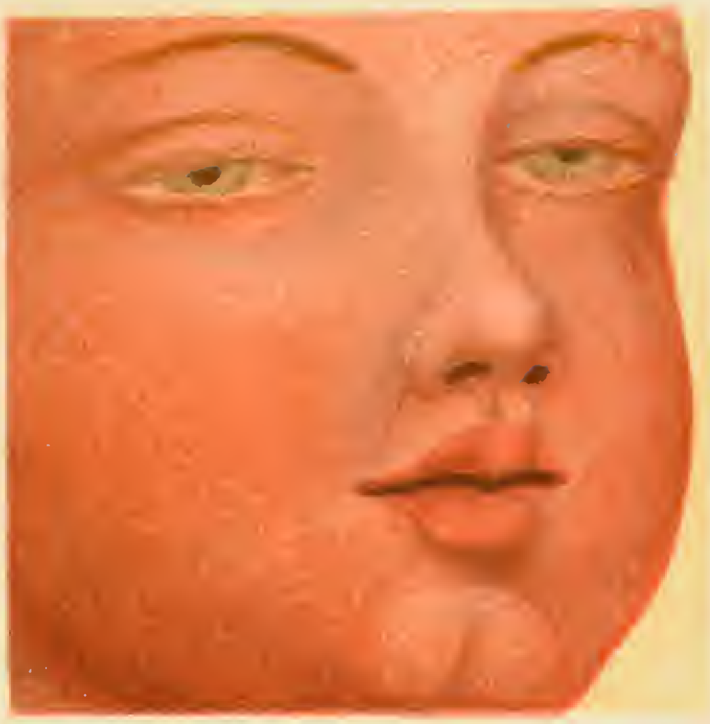
Plate XXVII

ERUPTIVE FEVERS.

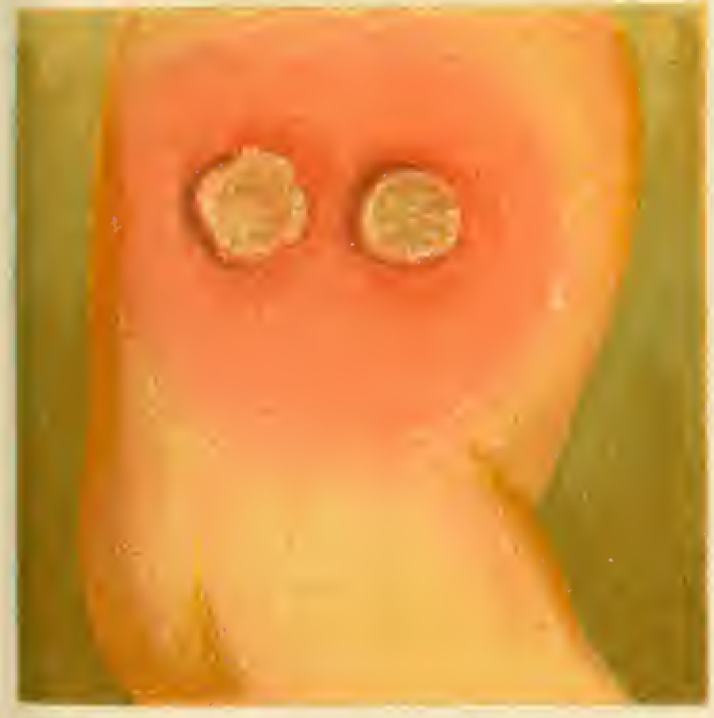
THE APPEARANCE OF THE RASH



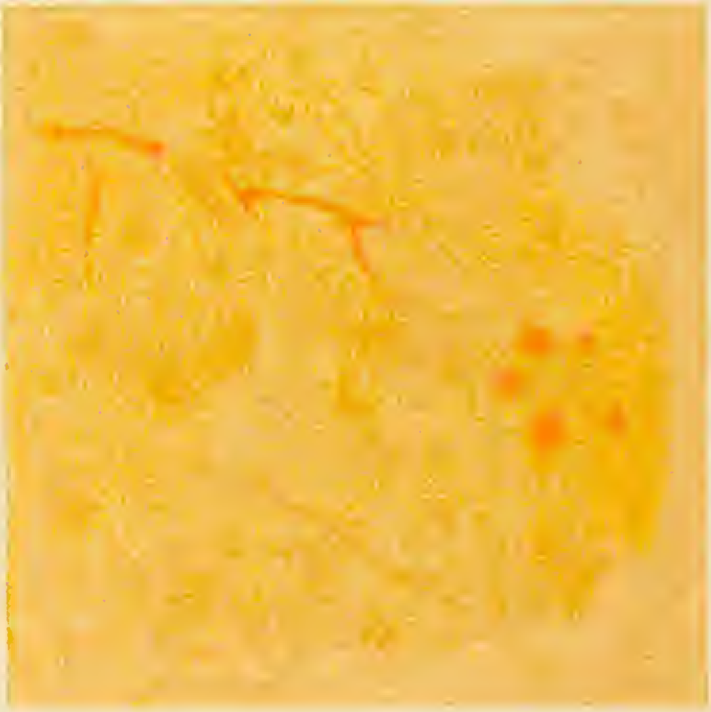
Measles. p 521



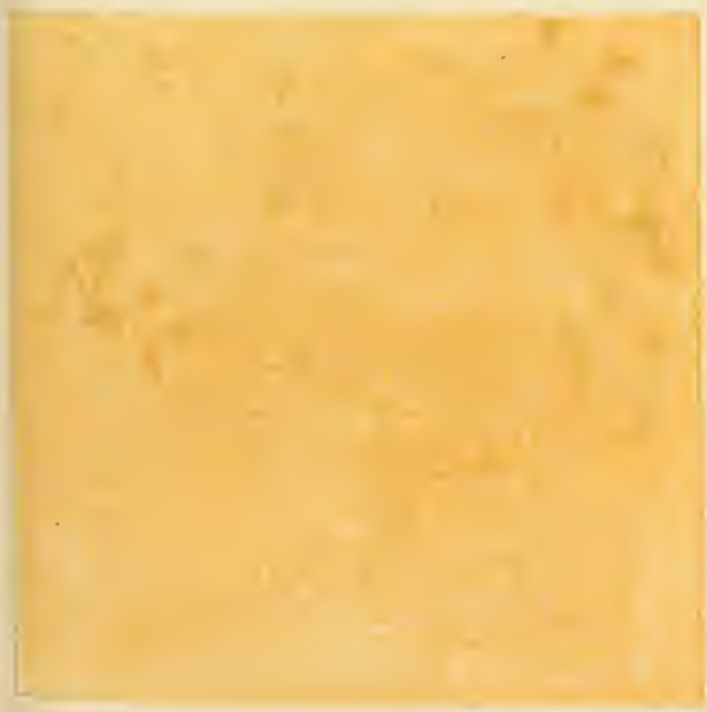
Scarlatina or Scarlet Fever. p 519



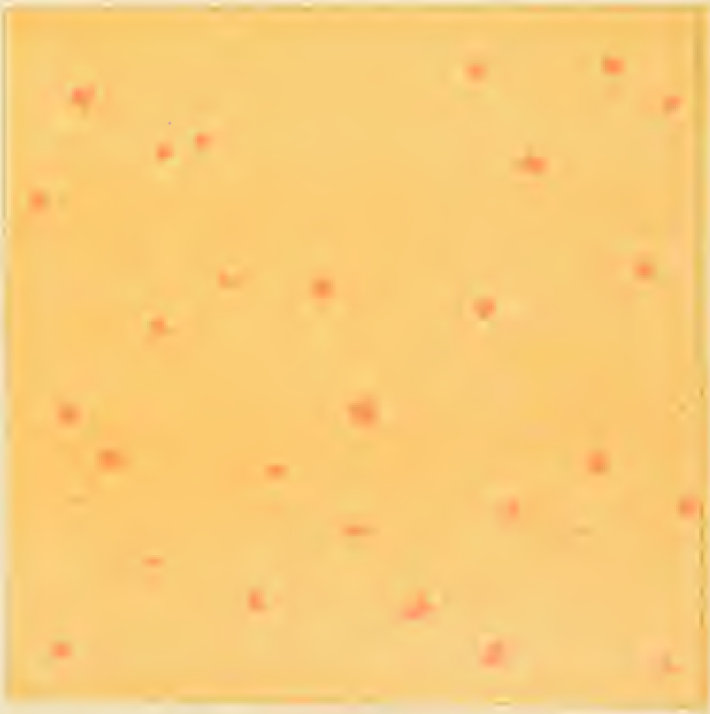
Vesicle of Vaccination on 9th or 10th day with slight Rose Rash around it p 526



Typhus in early stage, 7th day ordinary case p [illegible]



Typhus in advanced stage 13th day.—Spotted Typhus. p 531



Typhoid Enteric, or Gastric Fever, about 16th day Rose Rash of Typhoid p 532

cases it ends by **lysis**, meaning a loosening (Greek, *luo*, I dissolve).

6. The fever attacks the same person once only as a general rule.

Some of these diseases are much more catching than others, scarlet fever, measles, and small-pox for example. Typhoid fever, on the other hand, can be easily confined if great care be taken to disinfect the patient's discharges and to prevent them getting into any water-supply. It is also important to notice that in no other way can such a fever arise than by its seed having been sown. It cannot arise anew. It never can be caused by exposure to cold merely, by errors in diet, or in any such way. It cannot, therefore, arise from the entrance into a house of mere sewage gas. A house may be badly drained, and gas from the sewers may thus pass into the house. This is undoubtedly a great evil, because the inmates of the house, breathing the bad air, are liable to suffer from headache, sickness, sore throats, and various other states of ill health. The persons, weakened in their general health, are thus ready victims for any disease they may come in contact with. But the gas from the drains, *pure and simple*, cannot produce measles, scarlet fever, diphtheria, typhoid fever, or any other special fever. It is only possible for such a fever to be communicated by drains if the particular poison that is the cause of the fever has been cast into the drains from some previous case. The mere fact of a drain of a house being in a bad condition is not, therefore, sufficient evidence of the source of a special fever.

The period of incubation (hatching) varies for different fevers, as shown in the table below. This is not to be forgotten in trying to trace the source of the disease. A person may move from one part of the country to another, and, some days after he has entered his new abode, fever may declare itself in his household. The disease may have been brought with him from his old place of living.

While these fevers always have a definite course, the illness may not end with the natural conclusion of the fever. Some disease of kidneys, lungs, bowels, or other organs may arise in the course of the fever, prolonging the illness or causing death. It is to such causes, **complications** as they are called, that relapses are usually due, and not, as a rule, to renewed attacks of the original fever.

The facts that these special fevers have a regular progress of their own, and will end at a certain time unless some complication arises, afford important indications for treatment, which have already been discussed, p. 507.

Table of Fevers attended by Rash.

Name of Fever.	Period of Incubation (Hatching).	Rash appears.	Rash fades.	
Scarlet Fever.	4 to 6 days.	2nd day of fever.	5th day of fever.	Scarf-skin begins to peel by 10th day, and continues separating for 4 or 5 weeks after.
German Measles	14 to 18 days.	In 24 hours.	3rd or 4th ,, ,,	Rash resembles both true measles and scarlet fever.
Measles.	12 to 14 ,,	3rd or 4th day of fever.	7th ,, ,,	
Small-pox.	12 to 14 ,,	3rd ,, ,,	Crusts of pox begin to fall about 14th day.	Rash first pimples, then blebs, then the fluid of the blebs becomes matter, and by 14th day has dried into crusts.
Chicken-pox.	13 days.	1st ,, ,,	Crusts begin to fall about 7th day.	Rash of pimples becomes blebs; scabs formed by 6th day.
Typhoid Fever (Enteric Fever).	Uncertain. In some cases 21 days.	7th or 8th ,, .	Comes out in crops, till end of 3rd week.	Fever gradually passes away after 21 days, but is often prolonged by complications, &c.
Typhus Fever.	5 to 12 days.	5th to 7th ,, ,,	Beginning of 3rd week.	Fever lasts 14 days. Crisis at end of 2nd week.
Dandy-fever (Dengue).	5 to 6 days.	3rd ,, ,,	5th or 6th day of fever.	Second attack of fever and rash follows first after 2 or 3 days, lasts shorter time.

SCARLET FEVER AND SCARLATINA.

(Plate XXVII.)

Scarlet Fever is extremely infectious, very common among children, and often more dangerous because of its consequences than on account of the actual fever.

The **symptoms** of an ordinary case are that the person complains of shivering, weariness, headache and sickness, and *sore throat*. In children a convulsive fit, instead of shivering, not seldom begins the illness. There is great heat and dryness of the skin, and frequently the dulness and drowsiness of the patient are quite marked. Some amount of delirium is frequently present. There is thirst but no desire for food. The pulse is very fast. The appearance of the tongue is peculiar. It is thinly coated with a white fur, but is red at the edges and tip, and numerous minute red points are seen standing out, giving an appearance indicated by the phrase: "strawberry tongue" or "raspberry tongue." This, however, is not seen till the fourth or fifth day of the fever. The sides of the jaws are slightly swollen, stiff, and sore. On the *second* day of the fever the rash comes out. It comes out in fine red points so numerous and grouped so closely that the skin appears red all over. Appearing first on the face, sides of the neck, and breast, it is soon spread all over the body. It is most intense by the fourth day, and begins to fade on the fifth, disappearing before the end of the seventh. The intense redness of the skin may be shown, by contrast, by drawing the point of the finger firmly over it. A white mark is produced, to which the redness quickly returns. The soreness of the throat may be felt a day or two before the fever—it increases up to the time of the rash appearing,—the tonsils (p. 195) being very red and swollen, and in ordinary cases it diminishes when the eruption reaches its height. With the fading of the rash the pulse becomes less quick, the fever lessens, and all the symptoms improve, and in the course of a few more days the fever has departed.

With the disappearance of the rash another peculiarity of the disease presents itself, namely, desquamation or shedding of the skin. The scarf-skin begins to separate in fine or large scales, or in large flakes. It begins on the neck and chest, spreads to the other parts of the body, and to the hands and feet last. Sometimes the scarf-skin of the hand will separate all together as a glove, or that of the foot like a slipper. As a rule, desquamation is not complete till after the *sixth* week from the beginning of the fever.

The chief symptoms are the sore throat, the scarlet rash, and the shedding of the skin.

Scarlatina.—The attack may be mild, exhibiting the main symptoms but in a very slight degree, and often after the first day or two the patient is so little affected that he or she seriously objects to the confinement. It is to this form the term **scarlatina** is applied. It means merely a mild attack of scarlet fever. Practically, however, *the mild attacks are often found to be more serious than the severer form* just described. *Scarlatina is capable, by infection, of communicating the worst type of the disease, causing rapid death.* Moreover, the evil consequences, so common in the disease, as readily attend the mild as the severe form. In a mild case it is often difficult to impress the patient, or, in the case of a child, its parents or nurse, with a due sense of the risks. Less care is exercised, there is improper exposure; and dropsy or other symptoms of kidney disease speedily appear. *The mildest case of scarlatina ought to be treated with the same watchful care as the most severe.* There are even milder cases of scarlet fever than those noted. A child is feverish and unwell for a day or two, and apparently becomes quite well, though unusually pale and not strong. No rash has been noticed. But, in a week or ten days after, the glands at the side of the jaws swell, the ears become sore, perhaps the skin peels, or other symptoms lead to the conclusion that the child has suffered from scarlet fever.

Again, there is a malignant form of the disease, in which there are great brain disturbance, convulsions, and low muttering delirium. The tongue is dry, the throat dark-red, ulcerated, and sloughing. The rash comes out late, and speedily disappears. Death may occur before the rash has time to appear.

Scarlet fever occurring at or immediately after childbirth assumes very fatal characters.

The **results** of scarlet fever are many. Abscesses may form in the throat or in the glands at the sides of the jaw; suppuration may occur in the nostrils and in the eustachian tube (p. 464) leading to the ear. Disease of the ear, accompanied by discharge and ending in deafness, is common. Various affections of the membrane surrounding the heart (pericardium, p. 318) and lung (pleura, p. 359) may arise. Rheumatism is apt to follow. The commonest result is inflammation of the kidneys (p. 399). Inflammations of the eyes are not infrequent.

The **infection** of scarlet fever is undoubtedly at its worst during the shedding of the skin, but not at this period only. It is very probable that the sore throat is also infectious, and that therefore the disease is "catching" from its commencement to its termination.

Treatment.—*Disinfection should be practised from the beginning in the manner* advised on p. 516. At the beginning of the disease nothing is more valuable than the warm lysol bath (see p. 508), which should be daily repeated.

If the fever runs high, the cold sponge (p. 510) should be substituted. The patient should be kept strictly to bed in a well-ventilated room, in which a fire is kept burning. For food, milk, 1½ to 3 pints, according to age, every 24 hours, is the best, given every hour diluted with barley-water, soda-water, or aerated water. To encourage the action of the skin and kidneys the ammonia and ether mixture is valuable (p. 511), and the treatment detailed on these pages is applicable. Inhaling the steam of boiling water or sipping warm milk relieves the throat. A warm application over the throat may also be used if the pain is severe. Sometimes nothing is so soothing as allowing a piece of ice to melt in the mouth, and with children giving a tea-spoonful of iced milk or water now and again. When the skin begins to separate, the body, after the bath or sponging, should be rubbed all over with carbolic or camphorated oil. This prevents the scales of the skin being scattered through the air. This should be repeated daily till all the skin has separated. The patient should not be permitted to leave his room or mix with others till all the skin has been shed, and then only after proper disinfection. See pp. 516, 517.

Milk should be the exclusive diet till the fever has ceased, and after that, milk with bread, and bread and butter, and milk puddings made without egg, should be the diet for other three weeks.

All cases should be in the care of a physician. Discharge from the ear should, from the very first appearance of it, be treated as advised for that affection on p. 490.

If the kidneys become involved, the hot bath should be given (p. 509), followed by a dry pack, or the hot pack only may be given and repeated once or twice daily.

MEASLES AND GERMAN MEASLES.

(Plate XXVIII.)

Measles (*Morbilli—Rubeola*).—This is an infectious disease occurring most commonly among children, not because grown-up people are less liable to be attacked, but because most people have it in childhood, and one attack protects against another. This is not a rule, however, that has no exceptions.

The cause of the disease is, without exception, contagion; that is to say, a special kind of poisonous material is thrown off from the body of a person suffering from measles, which, gaining entrance to the body of a healthy person, gives rise to a new case of the disease. Measles thus spreads, like scarlet fever, from person to person, one case being capable of infecting any number of others. It clings to clothing and to other surfaces. Many people forget this. Parents too often forget it when they send their children out to play, or back to school, a sufficient time after their recovery, but without previously disinfecting their clothing. It is for such reasons that, when one of a family is sick of measles, the others, if they are living in the same house, should be kept at home, not only from school but from playing with neighbours' children, lest they spread the fever. Measles is infectious even before the rash has appeared, and therefore even before the real nature of the affection is quite certain. A patient may, thus, have already imparted the disease to others before it could be known that he was suffering from it. This is different from scarlet fever, in which the chief period of infection is while the scarf-skin is separating—the period of desquamation as it is called.

A measles-infected person may infect others during the incubation period, as well as during the period of illness, and for 14 days after the appearance of the rash, that is, during a total period of 4 weeks. Of course the infection may cling to rooms and clothing, that have not been disinfected, for a much longer time.

Symptoms do not show themselves till from twelve to fourteen days after infection. The attack begins with signs resembling those of cold-in-the-head (catarrh, p. 214). There are chills or shivering fits, in children sometimes convulsions, followed by evident fever. The appetite is lost, the tongue white, and there may be vomiting. Cough is present, generally of a harsh barking character. There is sneezing, the eyes are red and watery and sensitive to light, and the head aches. These symptoms increase up to the fourth day, when the rash begins to appear, at first on the forehead and temples, at the edge of the hair, and then on the cheeks, chin, and neck. It then extends downwards over chest, arms, belly, and legs. On the fourth day the fever seems to be at its height. It may reach 104° Fahrenheit (see p. 38), accompanied by rapid pulse and sometimes delirium. The rash consists of well-marked, red, roundish spots, *raised above the skin.* Appearing first here and there, they quickly form groups, which run together into irregular patches. When they are numerous the skin is swollen. The face is thus very red, and irregularly swollen and rough, when the rash is well out. The spots being raised above the surface, the skin feels very rough, and so measles is easily distinguished from scarlet fever, in which there are no raised spots but only a general redness. If the rash is well "out" by the fourth day, then on the fifth the fever usually is much diminished, the cough is softer, and the pulse less rapid. Within two days of its appearance the rash begins to fade, disappearing from the different parts in the order in which it came, but leaving a mottling of the skin, of a dusky colour, which does not completely fade for ten days or longer. Very fine scales separate from the skin, of the face and neck in particular, on the disappearance of the rash. In ordinary cases the fever has almost passed away by the seventh day, leaving the patient weak.

It is very common for the cough to be the first thing to attract attention. A child, who has been restless during the day, rouses its parents in the night by a hoarse barking cough, which immediately suggests croup to their minds. It has not the metallic, brassy ring of croup, however, for which it may be mistaken till, in one or two days, the measles rash appears.

Measles is not the very simple disease that many people seem to imagine. Bronchitis is a very common complication, maintaining the high fever beyond the sixth or seventh day, delaying recovery, or causing death. In young children the attack of the disease with the accompanying affection of the chest may be so severe as to cause death before the rash has time to appear. In hot weather an attack of diarrhœa is serious, and in hot climates dysentery is not an infrequent bad attendant of the attack. In delicate children, measles is apt to leave very weakened conditions of general health. Inflammation of the eyes, discharges from the ears, and swellings of glands often follow an attack of measles in unhealthy children, and are very difficult of cure.

Persons may suffer from measles and mumps or whooping-cough at the same time.

Treatment.—From the very beginning the patient should be separated from others, and steps should be taken for disinfection, as described on p. 517. The person must be kept quiet in bed in a room kept at a regular degree of warmth, but yet with plenty of pure air. Draughts should be carefully avoided. Sunlight should be freely admitted to the room, but the bed shaded from it. The bed clothing should be light. Milk should be the only diet for a week or ten days, given, a cupful at a time, every two hours or so during the day. If the fever is high and the patient restless, the warm lysol bath is of great service (see p. 508). The child should get such a full bath for eight minutes morning and evening at a temperature of 98°. The cough may be relieved by gargling the throat with warm milk or sucking a small piece of ice. To aid the action of the skin and kidneys the mixtures noted on p. 511 may be used as required.

If convulsions occur, a warm bath or pack should be employed (p. 508).

After ten days the food should gradually return to the full ordinary diet. A dose of mild opening medicine is occasionally necessary, but it is to be carefully given, from the risk of looseness of the bowels.

Affections of the ears and eyes are to be treated as recommended in Section XXIII.

German Measles (*False Measles*, *Rötheln*, *Rubella*, *Epidemic Roseola*) is apt to be mistaken for measles and scarlet fever. It differs from measles in there being little sneezing, little cough, and nothing of the red watery eyes, all of which are characteristic signs of measles. It is a different disease from measles, for, while one attack of measles protects, as a rule, from a second, an attack of false measles gives no protection from true measles. It never develops into true measles, though a child may have a real attack of measles shortly after an attack of German measles. It is not so contagious as true measles. The affection does not show itself till from one to two weeks after infection.

Symptoms.—The disease is marked by an eruption, appearing first on the face and quickly spreading over forearm and hands, legs and feet, and rapidly covering the whole body. The spots are *raised above the skin*, of a dusky red, irregular in shape, and they soon run together. This eruption is accompanied by little fever. The patient may complain of a feeling of fulness of the head, of giddiness, and perhaps of some headache, in short of being a little "out of sorts," and frequently does not complain at all. In true measles, as noted on p. 521, there is considerable fever, with severe cough, sneezing, and other signs of cold-in-the-head, and the fever usually reaches its height when the rash appears on the *fourth day*. Now, in false measles, if there is any disturbance before the fever it is slight, and usually the rash appears *within one day, or at the most two days*, of the person feeling unwell. It does, however, sometimes happen that there is considerable fever, loss of appetite, &c., before and during the rash, and in young children the disease occasionally sets in with vomiting, diarrhœa, and convulsions. On the second day the rash is fully out, and immediately begins to disappear, fading by the third or fourth day. A symptom more distinctive than the rash is the presence of enlarged and tender glands down the sides of the neck, at the back of the neck, and sometimes in the armpits and groins.

Treatment.—Rest in bed for three or four days, and such mild diet as recommended for measles are sufficient treatment. The infectious character of the disease must not be forgotten, and, as the infection probably lasts for some weeks, care should be taken that the disease is not spread. The warm lysol bath should be daily used as recommended on p. 508.

SMALL-POX.

(Plate XXVIII.)

Small-pox is a contagious and infectious disease. Its chief feature is the appearance of a rash on the skin, consisting first of pimples, which enlarge and become little sacs filled with clear fluid, afterwards changing into matter. Scabs form when the matter dries up, and on their fall they leave marks or not according to the severity of the attack. There are different degrees of severity of an attack of small-pox, indicated by the eruption. In the less serious form the different pocks are separate from one another, and the small-pox is said to be **distinct** or **discrete**; in a more violent form the pocks run together, and the disease is said to be **confluent**. The former kind is often fatal, the latter nearly always so. The disease, like other contagious fevers, has a period of incubation, there is, that is to say, an interval between the time when the disease is caught and the time when it begins to show itself. That period is from twelve to fourteen days. In all cases several stages can be recognized in the progress of the fever. These stages are—that of *invasion*, the period of the beginning of the attack; that of *eruption*, the period when the rash appears; that of *suppuration*, the period during which the contents of the pocks become matter; and that of *drying-up* or *desiccation*, when crusts form. The time of these stages may be given. As a rule the fever begins *twelve to fourteen days after* the disease is "caught;" *on the third day* of the fever the eruption appears; *about the eighth day* suppuration begins, and lasts till the eleventh, after which the drying-up process goes on; the scabs tend to separate *about the fifteenth, eighteenth, or twentieth day*. These are the times for the appearance, suppuration, and drying-up of the eruption *on the face*. On other parts of the body the various stages are a little later in occurrence.

Distinct Small-pox.—The chief symptoms at the beginning of this form are fever and headache, vomiting and costiveness of the bowels, and severe pain in the small of the back.

The attack is usually sudden. The patient is seized with shivering-fits (rigors) followed by great heat of the skin. The sweating is marked for several days in grown-up persons, not in children. In children also diarrhœa (looseness of the bowels) is usual and not costiveness, but in adults diarrhœa is rather the indication of a very severe attack. Convulsions are also common in children. The pain in the back is usually severe, and may be attended by numbness or paralysis of the legs and difficulty in making water. Instead of the severe pain in the small of the back, there may be dull pains throughout the body like those of rheumatism. During this time the fever runs high.

With the beginning of the *second stage*—the appearance of the eruption—the fever falls and the other symptoms disappear, so that the patient may seem to be almost well. This continues till about the eighth day, when the fever returns with the suppuration of the pocks. The eruption, as it appears on the third day, consists of small red hard points, slightly raised above the skin. They grow larger, and in the course of a day form hard prominent pimples. In the course of two more days they have become converted into vesicles, that is, small sacs or blebs containing a milk-like fluid. They go on increasing in size. On the eighth day the fluid they contain has become yellowish, and consists of matter or pus. Hence the eruption consists now of pustules, or small abscesses. On this day, also, the skin around each pock or pustule is distinctly red. There is, indeed, a ring of inflammation round each. Accompanying the inflammation there is swelling in the skin and parts beneath it. The pustules are painful and the fever returns.

The return of the fever marks the arrival of the *third stage*, that of suppuration. The pustules still increase in size, and the yellowness of their contents becomes more visible. This stage is marked also by swelling, already noted, of the parts on which the eruption is seated, which increases up to the *ninth day* of the disease, and then diminishes, disappearing about the eleventh day. It is greatest where the skin is loose, and thus is often very great on the eyelids, causing complete closure of the eyes. It is marked on the hands and feet. The fever of the period of suppuration may not be so high as the early fever. It is accompanied by shiverings, quick pulse, loss of appetite, furred tongue, and delirium. It lasts for three days, and then, if the case progresses favourably, rapidly disappears, not to return, and the other symptoms with it. The pustules thereafter pass through the process of drying-up, to be noticed immediately.

The eruption does not appear all over the body at once. It begins on the face and neck, spreads to the upper part of the chest, arms, and hands, to the rest of the body later, and to the legs last. In the course of two days it will have spread over the body. But those on the face having appeared first, will always be in advance of the others, and thus those on the face may be dried up while those on the legs are only fully ripe. The eruption is also present on the lining membrane of the throat and mouth, and causes pain in the throat, felt from the commencement of the rash. It is also sometimes present on the lining membrane of the eyelids (the conjunctiva, p. 447), and may lead to serious injury of the eyes. The pocks on the body have often a depression in the centre, not seen in those on the face. Pocks showing this are said to be umbilicated.

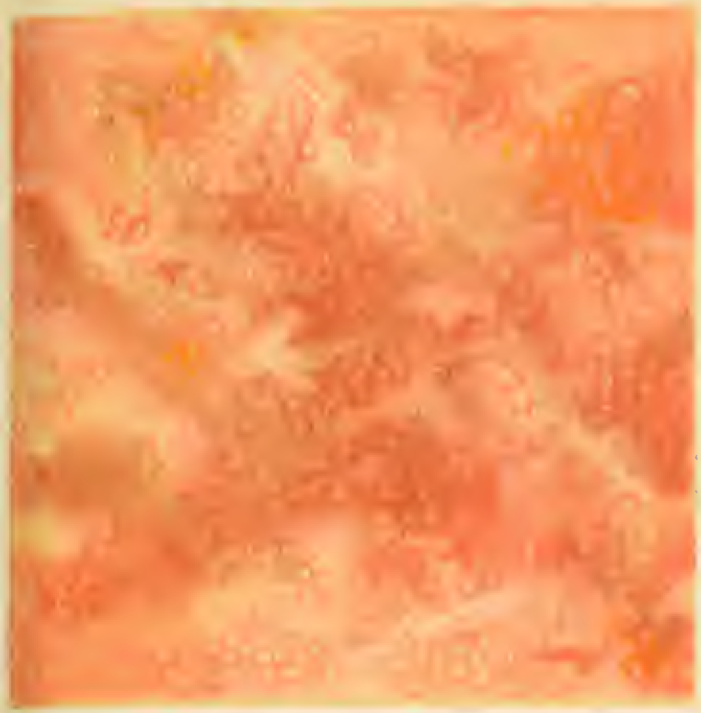
The *final stage* of small-pox is that in which the pustules dry and form scabs. The scabs begin to fall from the face between the fifteenth and twentieth days, and a little later from the body. A red prominence is left, after the fall of the scab, on which scales form, and from which they fall for, it may be, several weeks. Finally, after some months the redness disappears, and a white scar is left, below the level of the rest of the skin. If the pocks have not been large, the marks may be very slight.

Such is the history of **distinct small-pox.** It is one of the least fatal forms of the disease, except in unvaccinated children below one year of age. Nevertheless it may prove fatal even in grown-up persons. When death occurs from distinct small-pox it happens about the eighth or ninth day. According to the French physician, Trousseau, a fatal issue is to be feared when the eruption does not come well out by the fifth, sixth, or seventh day, when the pustules are irregularly formed, when the sweating ceases suddenly and cannot be recalled, and when delirium occurs with dry cold skin and a weak, sharp, irregular pulse. Profound unconsciousness and twitchings of the tendons are signs of approaching death.

Confluent Small-pox.—The confluent form of the disease, in which the pocks run together, is a very fatal form. The symptoms of its commencement are similar to, but more severe than, those already described. The pains are more intense, fever more decided, and vomiting continuous. The eruption comes out earlier than in the ordinary case, appearing on the second day instead of the third, though in very bad cases the rash may be delayed. The fever is not only very high, but it does not fall for any time between the period of the rash appearing and the period of the pocks ripening, as it does in distinct small-pox. It is almost continuous till the pustules have become yellow with matter. The eruption, which, as already stated, appears early, and may at first be mistaken for measles because of the general redness of the face, consists of small pimples extremely close set. As they grow in size great swelling of the face is produced, and when they grow into blebs they so run together that large patches of raised skin are produced, like that caused by a blister. The swelling of the face is accompanied by swollen eyelids, swollen jaws and ears, and there are constant flow of water (saliva) from the mouth, and harsh cough. The ball of the eye may be fiercely attacked and vision destroyed. The swelling of the face and the flow from the mouth should begin to diminish by the eleventh day. At the same time there occurs great swelling of the hands and feet, due to the pustules, and the swelling is accompanied by pain. When the pustules have become ripe, full of matter, which occurs between the eleventh and thirteenth day, they give out a most disgusting stench, and the patient's skin is in a most serious condition, with the leaking pustules, ulcers formed from them, and often boils and abscesses, due to some extent to the irritation of the decomposing matter of the pocks. (Plate XXVIII.)

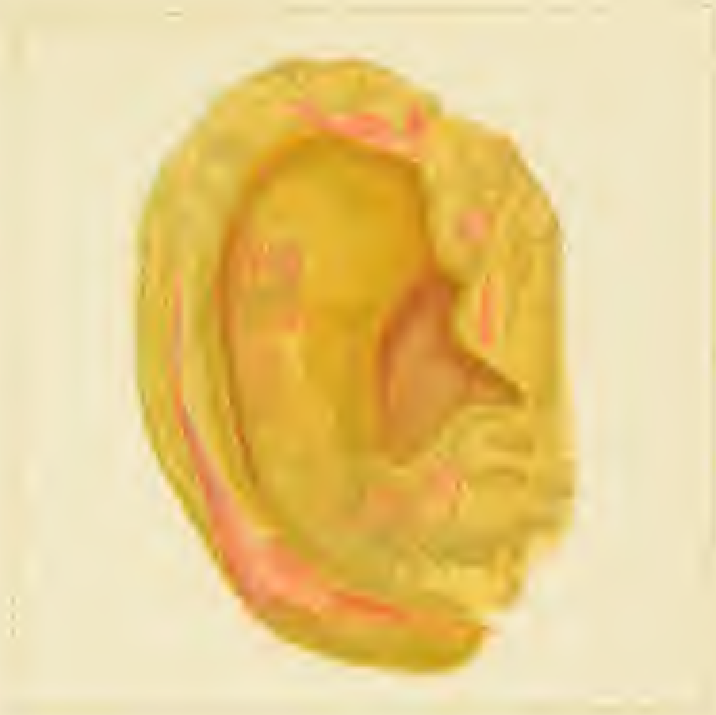
Delirium, in confluent small-pox, is apt to continue from the fifth day of the disease till the thirteenth or fourteenth day, when it should cease. But the fever has not such a defined period, for it may be maintained beyond the third week by the formation of boils and abscesses in the skin, and also in deeper parts.

THE APPEARANCE OF THE RASH IN SMALL-POX AND CHICKEN-POX



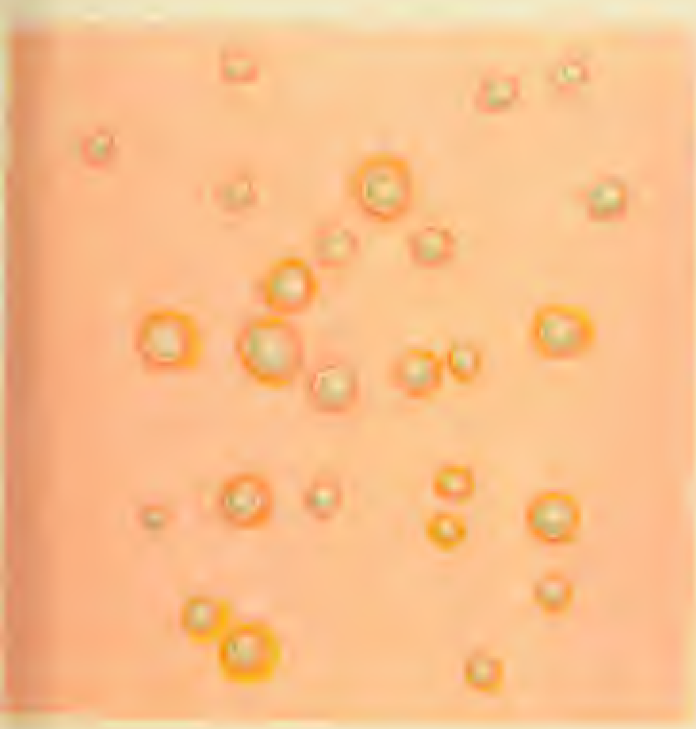
Confluent Small-pox in unvaccinated person. *(Early Stage.)*

p. 523



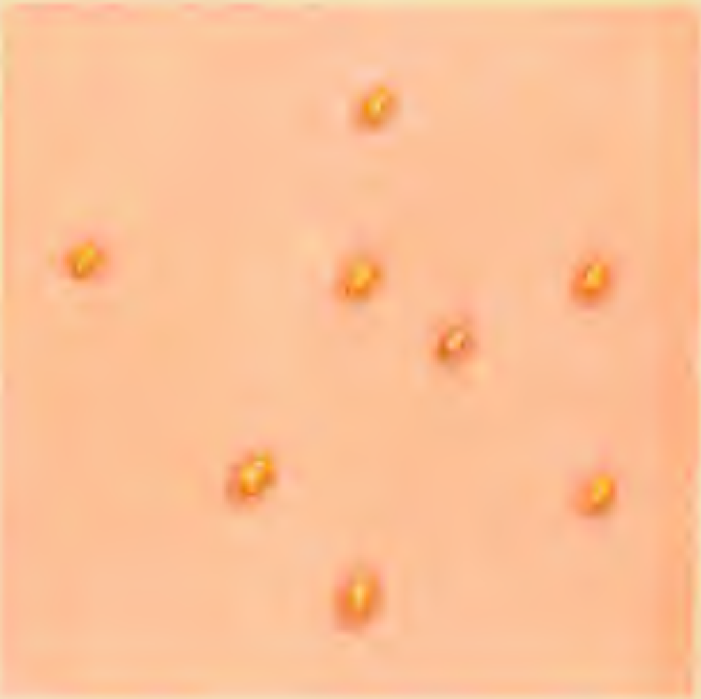
Ear in Confluent Small-pox. *(Mature Stage*

p. 523



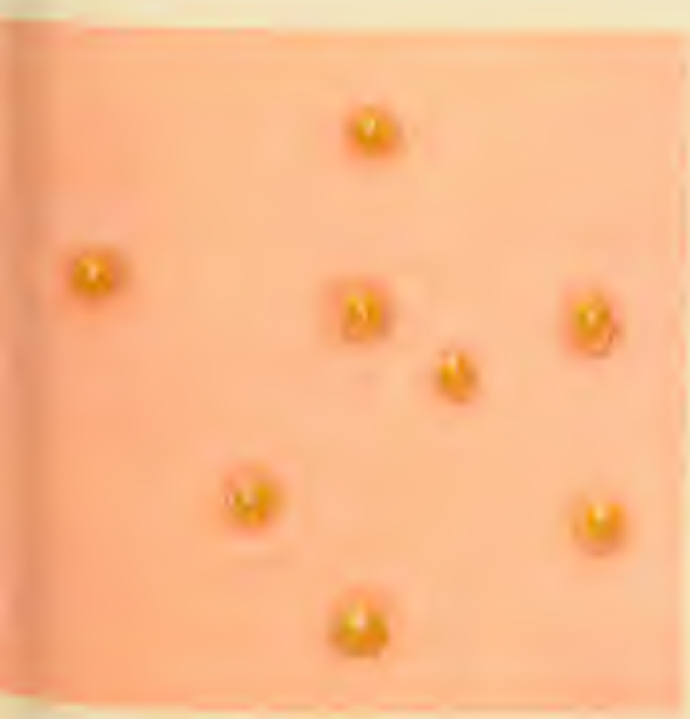
Chicken-pox 1st and 2nd day.

p. 530.



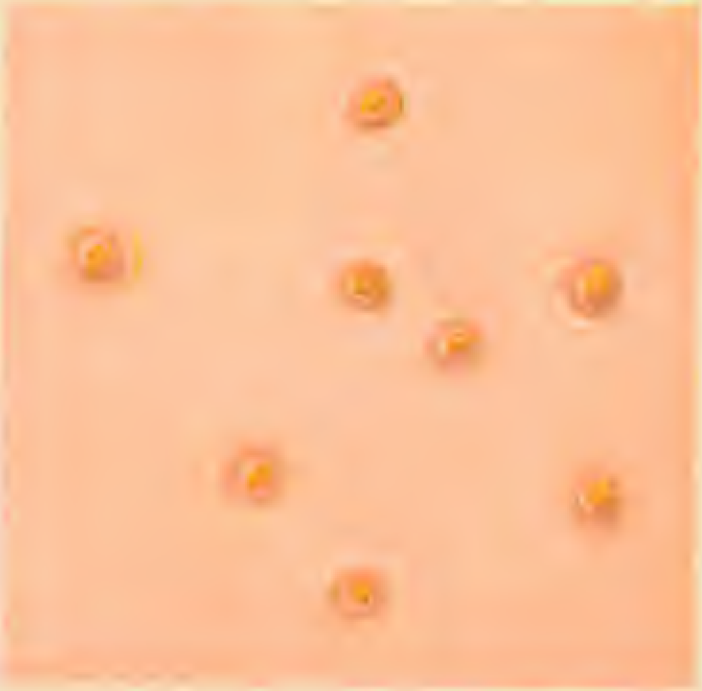
Small-pox, after Vaccination. 3rd day

p. 525.



Small pox, after Vaccination. 5th day

p. 525



Small-pox, after Vaccination. 7th day.

p. 525

At this late period attacks of shivering, with high fever, indicate the formation of deep boils.

In confluent cases death is very common, and usually occurs between the eleventh and fourteenth days. Excessive delirium, or deep unconsciousness, great prostration, much difficulty of breathing, and anxiety—these are all bad signs. Death sometimes arises from suffocation by swelling and the formation of membranes in the throat. Inflammation of the lungs may hasten a fatal termination. But even should the patient survive this period, prostration and death are too apt to be the result of the prolonged formation of boils, &c., in the skin and deeper parts.

Black Small-pox is the most fatal form, and is so called because, while the ordinary rash is scanty, there is an eruption of dark-blue, violet, or black spots. These are due to bleeding that has taken place into the skin, and in some cases blood is lost from the nose, mouth, and other parts. Such cases are accompanied by delirium and high fever and rapidly end in death.

Treatment of Small-pox.—As in other fevers with rash, no attempt need be made to arrest or cure an attack of small-pox. It will run its own course. The patient should be placed in a large well-ventilated room. The patient must not be heavily covered. His body and his bed should be kept as clean as possible; sponging with lukewarm water may be adopted, or the warm lysol bath, advised on p. 508, and the bed-sheets should frequently be changed. The skin may be anointed, after bathing, with carbolic oil or vaseline. Mutton broth, milk, beef-tea, &c., should be given in small quantities frequently. Lemonade, or gingerade, or acid drinks made with dilute sulphuric acid are grateful. If delirium and excitement are great, lukewarm baths are of use, and antipyrin in 2½-grain doses for children and 5 for adults every three or four hours. The attendants should have been vaccinated. A patient who recovers must not be allowed to mix with other persons till all crusts and scales have disappeared, and till daily baths for a week have been taken. The utmost care must be taken to prevent the spread of the disease, as advised on p. 517. During a small-pox epidemic all unvaccinated persons should be vaccinated, and among those who have been vaccinated, but as long before as seven years, re-vaccination should be practised.

Note.—If a person has been exposed to small-pox, and is ***immediately*** vaccinated, he may escape altogether. He may even escape if vaccinated within three days. If he puts off till the fourth day, he will probably take the disease, but it will be modified. Vaccination later than the fourth day after exposure is valueless.

Small-pox as altered by Vaccination (*Modified Small-pox—Horn-pox*).—While vaccination, if properly performed, as a general rule protects from small-pox, yet a vaccinated person may take the disease; but it does not run the ordinary course, and the risk attending it is slight. In the same way a person who has had small-pox is protected, as a general rule, from a second attack. Yet cases do occur where the disease attacks for the second time, and in this case also it does not run its full course. In both cases the disease is altered. It is, nevertheless, the same disease, for if a person suffering from the altered form communicates the disease to an unvaccinated person, in that person it will appear in the ordinary unaltered form. A vaccinated person suffering from a mild attack of small-pox may thus communicate the disease in its most aggravated form to an unvaccinated person. (Eruption is shown on Plate XXVIII.)

The **symptoms** of altered small-pox are up to a certain point similar to those described under distinct small-pox. The symptoms at the beginning are the same—shivering, fever, pains in the back, vomiting—but they are milder. The eruption comes out about the same time—the third or fourth day—but the pimples are few in number. They suddenly cease to progress in the usual way, and soon disappear. Or the eruption comes out as usual, progresses to the stage of forming blebs, and then dries up without any fever or suppuration. Even when the pocks reach a more advanced stage, swelling of the face, of the hands and feet, and other symptoms of the bad forms of small-pox are scarcely ever seen in small-pox altered by vaccination. In short the disease never gets a proper hold of the person. It may flourish for a few days, but speedily loses its hold and convalescence begins. Just as some seeds sown in particular kinds of soil may never produce good fruit, because the soil is deficient in the particular kind of nourishment they need, so that they spring up and progress to a certain stage only to wither away, so, in a person who has had small-pox previously, or has been vaccinated, there seems to be a want of the particular elements in the blood and body on which the small-pox poison flourishes. They either are, on that account, unable to take a second attack, or, if they take it, the disease advances only a little way and then abruptly terminates.

Inoculated Small-pox.—Long before vaccination was known it had been observed that persons who were inoculated with small-pox, into whose skin, that is to say, the small-pox poison was deliberately inserted, suffered usually from a milder form of the disease than those who caught the infection in the ordinary way, while at the same time they were protected from another attack. It appears that the habit of inoculating small-pox was practised from time immemorial in Persia and China, just because small-pox was so common that few could escape it, and because the attack was less likely to be fatal when deliberately communicated in this way. An English lady, Lady Mary Wortley Montague, observed the practice while residing in Constantinople in 1717, and had her son of six years of age inoculated with success. Returning to England she announced the practice in 1721, and had it performed with good result upon her daughter. As a result the practice spread, but met with much opposition. But after a time it was accepted, and generally performed till vaccination was introduced.

On the second day after matter from a small-pox pustule has been introduced under the skin of a person, a pimple appears at the spot. By the fourth day it has become a bleb, and by the seventh or eighth the milky fluid in the bleb has become matter, that is, the bleb has become a pustule. It is surrounded by a red inflamed ring, which increases up to the tenth day, and on which a number of smaller pustules appear, round the large one, which also increases in size. It is not till this time that any signs of general disturbance appear. But now shiverings occur, fever arises, headache and pains in the loins are felt, and there is vomiting—the usual signs of the beginning of an attack of small-pox. On the eleventh, twelfth, or thirteenth day after the inoculation the ordinary small-pox rash appears, which follows the course described under **distinct small-pox**.

Small-pox so produced is infectious, and an inoculated person might, therefore, originate an epidemic. Moreover, though usually mild, it was sometimes disfiguring and fatal. One can, then, understand how at one time the disease was feared and dreaded, when persons would run the risk of being inoculated rather than take the chance of escaping infection in the ordinary way. This is one of many facts of which the agitators who denounce vaccination are surely ignorant.

COW-POX VACCINATION, AND CHICKEN-POX.

(Plates XXVII. and XXVIII.)

In spite of inoculation, practised as described in the preceding paragraphs, the mortality from small-pox seemed to be on the increase in Britain, when, in 1798, Edward Jenner, a surgeon practising in Gloucestershire, published an inquiry into the causes and effects of cow-pox, and introduced the method of inoculating cow-pox as a preventative of small-pox. To this method the term **vaccination** has been applied, the word being derived from the Latin word *vacca*, a cow.

Cow-pox is a disease of oxen, manifested by the appearance, usually on the teats and udders of cows, of pocks, which almost exactly resemble those of small-pox. There is also a disease of the horse, called **horse-pox**, supposed to be the same disease to which the term **grease** is applied, which is believed to be the same disease as cow-pox. Cow-pox is a contagious disease, and is liable to break out as an epidemic among cattle. Now, anyone who milks a cow, suffering from this disease, is liable to get on the hands some of the matter from the pocks, and if by a scratch or other pathway the matter can pass into the system of the person, that person is likely to contract the disease, which will show itself by the appearance of pocks at the infected parts, but by no other symptoms of any consequence. It had been for long a tradition among dairy-folks that anyone who had thus contracted cow-pox was safe from the risk of an attack of small-pox. This notion Edward Jenner had become aware of while still an apprentice to a surgeon, and it took firm hold of his mind. For years he did not cease to think of it, to inquire concerning its truth, to make observations and experiments as well. For thirty years he worked quietly at the subject, and then he published his work on cow-pox, which completely established the truth of the old and vague idea, and raised it at once to the rank of a scientific fact. He gave details of persons who had accidentally contracted cow-pox, and who had remained proof against the infection of small-pox. He showed that persons who had thus been accidentally vaccinated were safe from small-pox even when small-pox matter was deliberately introduced into their bodies. He did more. He took matter from the pocks of a cow and introduced it into the skin of a child. In time this child showed the pocks of vaccination, now so familiar to everyone. With matter from this child he vaccinated a second, and with matter from the second he vaccinated a third, and so on through five generations. Then into the body of the child vaccinated last *he introduced small-pox poison and found it proof against the disease.* This was convincing evidence that the matter of the cow-pox could still protect from small-pox even after it had passed through the systems of many persons in succession. It was not, therefore, necessary to go back to the cow for matter. After the publication of Jenner's work his statements were subjected to tests of the utmost severity, and were found to be perfectly unassailable. Thus at the London Small-pox Hospital, in the two years following that of Jenner's publication, 7500 persons were vaccinated, and about one-half were afterwards inoculated with small-pox poison without the slightest effect.

Course of the Vaccination Pocks.— When a person has been properly vaccinated, nothing appears where the matter has been inserted till the second or third day, when a small red pimple shows itself. This grows larger and becomes, by the fifth or sixth day, a rounded grayish bleb filled with clear fluid, and usually not raised in the centre. It goes on becoming larger till the eighth day. After this the clear contents begin to become yellowish, the skin round the pock becomes red, inflamed, and thickened, and by the tenth day the skin for some distance round the pock is deeply red and hard, and the contents of the pock have become yellow matter. The pock now begins to dry up, and the inflammation and hardening round about to lessen, till by the fourteenth or fifteenth day the pock has changed to a dry dark scab, which falls about the twentieth day or a few days later, leaving a scar in the skin presenting numerous little pits, the surrounding inflammation having disappeared. If the vaccination has been successful the scar remains for life, and is easily recognized. A scar not well marked means imperfect vaccination; and, of course, the degree of safety from small-pox varies with the degree of effect which the vaccination matter has produced in the body of the person. During the progress of the pocks the person exhibits signs of being generally affected, but not, as a rule, before the eighth day. There is some degree of feverishness, restlessness, irritability, and disturbance of digestion, which soon pass off, but still indicate that the vaccination has produced more effect than simply a pustule at the place where the matter was inserted. If the pocks do not pass through the stages described, if, for example, a scab is formed on the fifth or sixth day which soon falls, the vaccination is not perfect and the protection is not complete.

Now the same pocks are produced whether the matter has been taken direct from the cow or from a person previously vaccinated.

The matter intended for vaccination should be taken from the cow or from the human being *on the eighth day,* while it is still clear and transparent.

Mode of Vaccination.— One of the most valuable parts of Jenner's work was the proof that the matter of the cow-pox could be passed through human beings for many generations without its value being lessened. From each fully grown pock sufficient matter can be obtained to vaccinate about a dozen persons. When the pock is opened by the fine point of a clean lancet, the clear fluid runs out, and this fluid may be placed on the skin of an unvaccinated person from the lancet point, and caused to enter the blood by the point being passed into the skin sufficiently deeply to reach the true skin. A simple method consists in making a series of scratches across one another (as in Fig. 203), with the clean lancet point, on the part of the skin where the matter is placed. The scratches should be just deep enough to show blood. If they are too deep, the flow of blood may wash the matter away. The upper part of the arm is usually chosen. The matter may be kept for any length of time in properly sealed tubes. Extremely fine hair-like tubes are used. When the end of the tube is placed in a drop of the fluid, the matter passes up by attraction, and when the tube is thus three parts filled, the ends are sealed in a flame. Or the matter may be placed on small slips of glass, or on clean quill points, and allowed to dry.

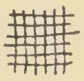


Fig. 203

When the matter is required for use, the ends of the tube are broken off and it is blown out on to the skin, or the plates or quills are moistened with a small drop of pure water and rubbed on the skin where the scratches are made. Thus from one good pock sufficient matter may be preserved to vaccinate half a dozen or a dozen persons.

Objections to Vaccination.—It might have been supposed that when Jenner had conclusively shown the value of his practice, and when cases by the thousand and tens of thousand confirmed his views, and proved that by means of vaccination a hateful disease, which killed thousands annually and mutilated for life many thousands more, could be rendered practically harmless, it might have been supposed that the acceptance of the practice would have been universal. But it was not so. Objectors rose on every side, and the more successful the method was shown to be the more vigorous became the opposition. One set of objections was sentimental. It was maintained that with the cow-pox some of the disposition of the ox would be imparted. It was declared that the moral character of children became perverted, that they exhibited the effects of a "bestial humour," that as vaccination was carried on the human race would degenerate, that innumerable evils would arise, that innumerable new and unheard-of diseases would appear, that brutal tendencies would appear in vaccinated children, and that even brutal features would show themselves, in the appearance of horns, hair, perhaps tails, in the expression of the voice, which would become bellowing, in the character, which would become bullying. Pamphlets and doggerel rhymes of the wildest description were published to throw discredit on the practice. The following verses from one of these sufficiently show the nature of this opposition :—

O Jenner! thy book nightly phantasies rousing,
Full oft makes me quake for my heart's dearest treasure;
For fancy, in dreams, oft presents them all browsing
On commons, just like little Nebuchadnezzar.

There, nibbling at thistle, stand John, Jem, and Mary,
On their foreheads, O horrible! crumpled horns bud;
There Tom with his tail, and William all hairy,
Reclined in a corner are chewing the cud.

Another kind of objection was of the pious sort. Small-pox was a "merciful provision on the part of Providence to lessen the burthen of a poor man's family;" it was impious to attempt to set aside a divine dispensation; &c. &c.

There were other and more serious objections. It was urged, and proofs were offered in support of the statement, that vaccination did not give the protection asserted, that many vaccinated persons were seized with small-pox, that vaccination so affected the system as to lay it open to such diseases as consumption, scrofula, &c., and that, with the vaccine matter, the poison of such diseases as syphilis might be and was introduced. The result of these more scientific objections was to rouse the supporters of vaccination to the fullest and most far-reaching inquiries. Medical colleges and medical men were appealed to in every civilized nation, and as a consequence a body of evidence in favour of vaccination was produced, which to this day stands unassailed and unassailable, fitted to convince every rational mind that vaccination, *if properly and universally employed*, affords a method of completely stamping out small-pox from the face of the earth. Anyone who chooses to examine the question for himself will find the facts in "Papers Relating to the History and Practice of Vaccination," presented to the British House of Commons, and published in 1857. Some of the most striking facts may be given. It is estimated that in 100 years before the introduction of vaccination, 45 millions of persons died in Europe of small-pox. In Greenland, in 1734, two-thirds of the population were swept away by an epidemic. In Iceland, in 1707, it destroyed 18,000 out of a population of about 50,000. In North America one tribe of Indians, numbering 1500 persons, all perished by its ravages excepting only 30. It is estimated that in the Russian empire alone it had *annually* two millions of victims. After the introduction of vaccination the death-rate from small-pox fell at once, and diminished just in proportion to the thoroughness and extent of the practice. In Sweden, before its introduction, small-pox had annually 2050 victims, after its introduction only 158; in Berlin, for 24 years before its introduction, the deaths from small-pox were 3422 annually, for 40 years after its introduction the annual death-rate fell to 176; in London the annual deaths from small-pox before vaccination were 3000 to 5000, after its introduction they were under 340. It is to be remembered that these results were obtained when vaccination was not nearly universal, and that the deaths were chiefly among non-vaccinated persons.

It appears, however, quite true that the protection from vaccination is not absolute. That is to say, there have been cases where persons properly vaccinated have yet contracted small-pox, but *in every case the disease was so mild as to cause little risk of death.* Such cases are, however, rare. It was abundantly proved that the very large proportion of cases brought forward, of persons who had contracted small-pox after vaccination, were really cases in which the vaccination had been improperly performed. It was shown that matter, in no sense true vaccine matter, might be used which would produce irritation at the point of insertion and set up inflammatory changes, which ignorant persons might suppose to be the vaccine pocks, but were not so. Such false vaccination could not give protection. While this was proved, it is admitted that in a few cases, indeed a very few cases, proper vaccination may not completely protect from small-pox, though it renders the disease extremely mild. But then there are undoubted cases on record where one attack of small-pox itself does not confer complete protection from a second. Indeed it would appear that the protective power of efficient vaccination is of the same extent as the protective power of a previous attack of small-pox.

The explanation of the protection accorded by small-pox is one that was surmised by Jenner himself. Numerous positive experiments go to show that the pocks of the cow and the small-pox of man, as well as (apparently) the pocks of the horse, are due to one and the same poison operating with different degrees of violence on different animals. Thus Mr. Ceely, a surgeon of Aylesbury, began a series of experiments in 1839, which went to prove that small-pox poison introduced into the body of a cow produced cow-pox. Thus, in one case, he introduced small-pox poison into a stirk. At the place of puncture the cow-pox appeared by the sixth day. From one pock he took matter with which he vaccinated several children, and in the children it produced the appearance of ordinary vaccination pocks. He passed this matter through several generations in children, and obtained a supply of matter which was used in the Small-pox Hospital and Cow-pox Institution of Dublin, and gave all the results of ordinary vaccination. Thus small-pox of the human being became cow-pox in the cow, and the matter of the cow-pox, when transferred to the human being, became the vaccination-pox. It thus appears that vaccination protects against small-pox because it is, as regards the poison producing it, the same disease, but deprived of its violence and extremely poisonous character by previous passage through the cow. Therein lies the reason why vaccination cannot protect more absolutely against small-pox than small-pox itself.

As tending to show how the objection that vaccination does not give complete protection against small-pox is rather an argument against imperfect vaccination, one or two facts may be given in the form of a table. The table is based on the observation of 5000 cases of small-pox received in the Small-pox Hospital of London. It states the death-rate among different classes of patients; (1) the unvaccinated, and (2) the vaccinated. But the vaccinated have been divided into different sets according to the number of vaccination marks or scars found on their persons.

Of unvaccinated, there died ...	35	out of every	100
Of those said to be vaccinated but having no mark, there died about	23	,, ,,	100
Of vaccinated—			
Showing 1 mark, there died nearly	8	out of every	100
,, 2 marks, ,, ,,	5	,, ,,	100
,, 3 ,, ,, ,,	2	,, ,,	100
,, 4 ,, ,, ,,	1	,, ,,	200

These figures are confirmed in the experience of other hospitals. It appears thus that the more thorough the vaccination the more complete the protection, and that that amount of vaccination is safest which leaves four well-marked scars.

It has been shown that the protective power of vaccination diminishes after the lapse of years. That objection is easily met. It is only necessary to have the vaccination repeated whenever necessary. (See Re-vaccination, p. 530.)

The gravest objection that has been urged against the practice is that vaccination has, in many cases, been the direct cause of serious disease. It is quite true that carelessness and want of cleanliness on the part of parents towards their vaccinated children may result in serious inflammation, erysipelas (rose), &c., of the vaccinated arm. But filthiness will render a pin-scratch a serious affair, and it is monstrous to suppose that parental neglect is to be an objection to a method for protecting the lives, not of one here and there, but of the whole community from a disgusting and fatal disease. Unfortunately there can be no doubt that syphilis has been communicated by vaccination. It has been shown, however, that pure vaccine matter taken from a syphilitic child cannot communicate syphilis to another child. It is only when the vaccine matter *is mixed with the blood* of the diseased child that risk arises. There are, therefore, two safeguards against such a danger, one is the evidence to the eye that the matter about to be used has no trace of mixture with blood, the other is due care in the selection of a healthy child from whom the matter is to be obtained. In short, care on the part of both parent and vaccinator are two absolute safeguards against the possibility of any danger arising from the practice.

But it would require proof of even greater dangers to justify any attempt to set aside a practice which has effectually subdued a disease that has swept away whole populations, and has every now and again made attempts to reassert its old evil dominion. The compulsory adoption of the practice is justified by the fact that every unvaccinated person is a danger to the community in which he lives. If the person who refused to be vaccinated endangered only himself he might be left till time and small-pox taught him his folly, but when it is remembered that every small-pox patient may be a source of infection to multitudes, a community is entitled to decree that no man shall be permitted to dwell in its midst without adopting the recognized precaution against the disease. "The wheel of time brings back the follies of the past oftener than its wisdom," and objections that were met and answered two-thirds of a century ago still find people prepared to urge them. Anyone who carefully examines the many documents on vaccination that are open for reference, can arrive at this conclusion only, that the opposition to vaccination can find supporters only among the grossly ignorant or the wholly irrational.

Rules for Vaccination.—Every child ought to be vaccinated within a very few months after birth. If the child is well and strong it is good to have it done by the third month, before the troubles of teething begin. *If, however, small-pox be in the neighbourhood no age is too early.* If the child be sickly or recovering from some sickness it ought to be postponed for some weeks till strength returns. Not less than two well-marked pocks should be produced, but four give the greatest degree of safety. Many people prefer to have their children vaccinated with matter from the cow, and there is, of course, no objection to this if the child be vigorous. For it is to be noticed that the effects of the cow's matter are more marked than those of matter passed through the human subject. But if the child from whom the matter is taken is thoroughly healthy there is no risk in the use of such matter, and it is as effective for the purpose. The arm which has been vaccinated should be carefully protected from rubbing and injury, and perfect cleanliness observed. Care should be taken that clothes do not press unduly up into the armpit to interfere with the natural flow of blood in the part. Many people employ shields for protecting the parts from rubbing; but they are apt to press unequally on the skin, to interfere with the circulation, and cause a much more than usual degree of swelling in the arm. A pad of sterilized wool is now sold by all druggists, which affords the best protection. Whereever small-pox is prevailing, all persons above ten at the utmost, who were vaccinated in childhood, should be re-vaccinated, and naturally no time should be lost in having vaccination performed on any who have never undergone the procedure.

Re-vaccination.—It is extremely desirable that all persons who have been vaccinated in childhood should be vaccinated again before the twentieth year, as a matter of course, but where any risk of infection is present, the second vaccination should be performed by the tenth year. Small-pox among adults who have been re-vaccinated is practically unknown. But, after the lapse of years, the protection against small-pox to those who have undergone the process only in childhood diminishes, though if they were attacked the disease would always be milder.

Chicken-pox (*Varicella*) has been supposed to be a mild form of small-pox. It is not so, for an attack of small-pox does not protect against chicken-pox, nor the latter against the former, although one attack of chicken-pox protects against a second. It is highly infectious; and children mainly suffer. The infection is caught from one to two weeks before the disease shows itself. That is, its period of incubation or hatching lasts that time.

Symptoms.—The disease shows itself by some degree of feverishness, restlessness, loss of appetite, and within twenty-four hours rosy-red pimples appear on the face, head, chest, and other parts of the body. These speedily become blebs, filled with clear fluid and surrounded by a ring of inflammation, enlarging till they may be equal to the size of a split pea. Within a week the blebs pass through the stage of pustule, that is, the clear fluid becomes changed into yellow matter, and dries up into dark-coloured scabs. By another week the scabs have fallen, leaving red marks, which last for a time. The rash does not come out all at once, but in crops, so that for three or four days one set follows another. They may appear on the sides of the mouth and tongue. In ten days or a fortnight the disease has run its course. The disease has no evil results, though the child may remain weakly for some days after its disappearance. (Eruption is shown on Plate XXVIII.)

Treatment.—The child should be kept in one room, and have ordinary mild diet, milk, &c. No medicine is necessary. The use of the warm lysol bath (p. 508) is very soothing to the irritated skin. It should be given daily for ten days. Separation from other children ought to be insisted on, as the disease is so infectious.

TYPHUS FEVER AND TYPHOID OR ENTERIC FEVER.

Typhus Fever is a very infectious fever. The infection seems to come off from a patient in the breath, and not, as in typhoid fever, in the motions from the bowels. The infectious matter, however, does not seem to thrive in the open air, nor does it attach itself to clothing, &c., or retain its poisonous characters as that of scarlet fever does. For free ventilation and plenty of fresh air are not favourable to the spread of typhus. It is probably for this reason that typhus is largely a disease of the poor, especially of the poor crowded together in small, ill-ventilated, and dirty houses. It is specially common in overcrowded parts of the poorer districts of towns in Great Britain and Ireland. It attacks both sexes almost equally, and at all ages, though the majority of those attacked are between the ages of ten and thirty. The greatest number of cases occurs during the winter and the smallest during summer, perhaps because in the winter the very poor huddle together for warmth, and the condition of overcrowding is thus readily produced. It usually attacks the same person only once, although there are cases of the same person suffering from it twice or even thrice.

Symptoms.—Between five and twelve days may pass after the person is infected before the symptoms of the disease appear. The first symptoms are shivering, headache, loss of appetite, thirst, and perhaps sickness, general weakness, quick pulse, and increased heat of skin. The bowels are bound. A noticeable symptom is dulness and heaviness of the patient, who has a stupid, confused look, and cannot fix his mind upon anything; and sleep is disturbed. About the fifth or seventh day the rash comes out (Plate XXVII.). It is apt to be mistaken for measles, but the spots, which are of a dusky-red colour, are not so large and raised as those of measles. It appears first on the sides of the chest and belly (measles appears first on the forehead round the edge of the hair), and on the hands, wrists, and elbows, spreading over the body, arms, and legs in a couple of days, but not marked on face and neck. After coming fully out it remains out for two or three days, and then begins to fade, disappearing by about the fourteenth day. In bad cases dark-coloured spots, due to the escape of small quantities of blood in the skin, may be present after the true rash has faded. During the second week of the illness the symptoms become worse. Delirium becomes constant, though, if sharply spoken to, the patient may be recalled to himself for a moment. Sometimes the delirium is violent, sometimes of a low, muttering kind. As the disease progresses the tongue becomes dry and brown, the pulse faster and weaker, and the general weakness so marked that the patient lies well down in the bed, on his back, with mouth and eyes half open, and motions and water are passed in the bed unconsciously. Often the hands wander aimlessly about, picking at the bed-clothes, a sign of great prostration. About the fourteenth day, in favourable cases, the patient falls into a gentle sleep, from which, after some hours, he awakes quite sensible, with the fever almost gone, but in a state of extreme weakness. With careful nursing appetite and strength gradually return, so that at the end of three or four weeks he is quite restored. If the case is going to end unfavourably the prostration increases, and instead of the turn at the thirteenth or fourteenth day, deep unconsciousness sets in, the fever runs up, and the patient sinks under it. Convulsions may occur, in such a case, before the unconsciousness comes on. The case may be milder than has been described, the delirium being limited to a "wandering," or it may be much worse, death taking place within the first week, instead of towards the end of the second, the usual time in fatal cases.

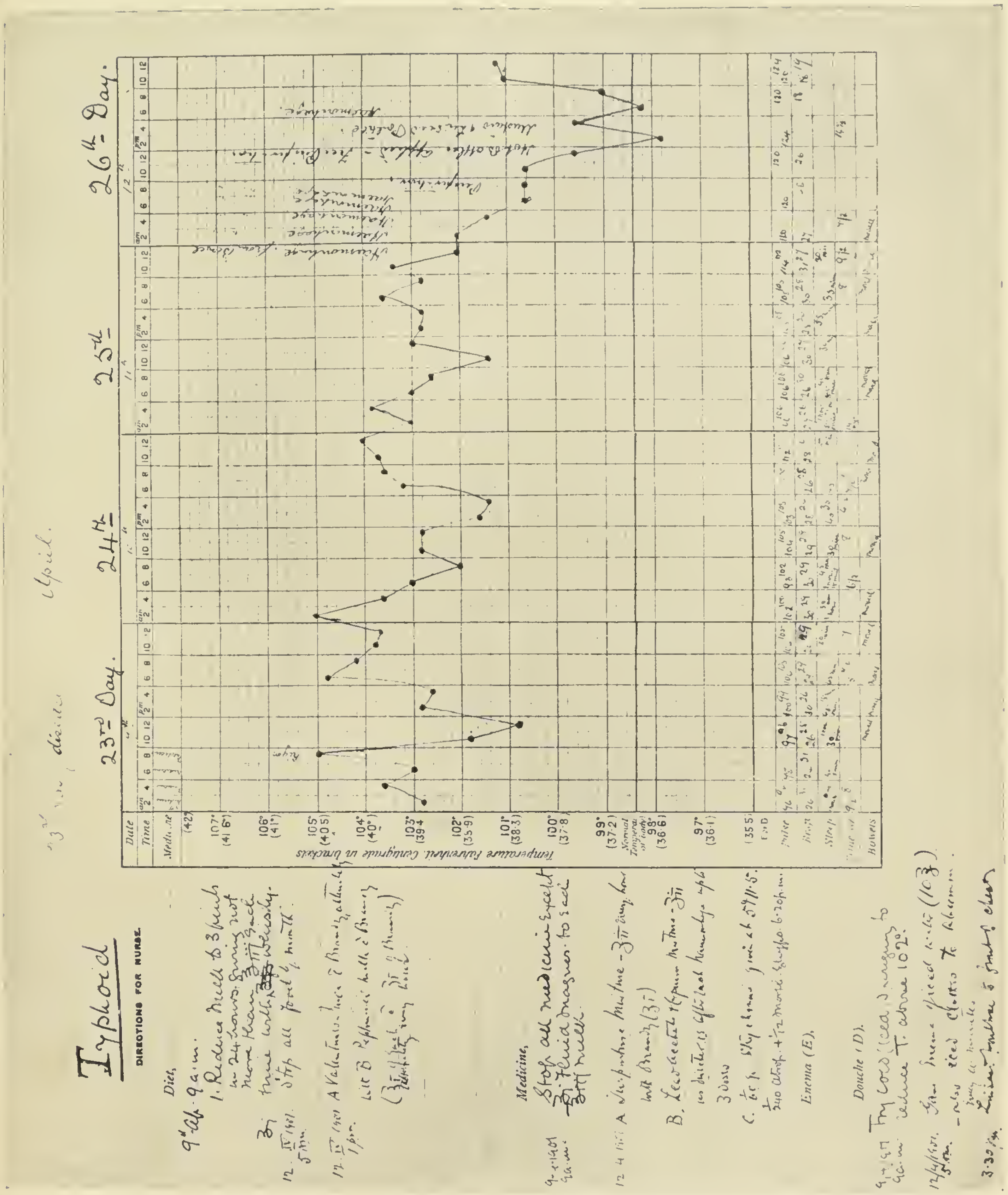
The chief complication in typhus is congestion of the lungs, largely brought on by the intense weakness produced by the disease.

Treatment.—The patient should be treated in a large well-aired room, fresh air being in this case the best disinfectant. He should be kept strictly to bed. Careful feeding is necessary. Sips of milk, beef-tea, nourishing soups from which all vegetables have been strained off, should be given *at short intervals.* The patient will in this way be induced to consume a large quantity in twenty-four hours, which he would not otherwise take. Thirst is to be relieved by barley-water, lemon-juice in water, or plain water. An occasional dose of castor-oil may be necessary to relieve the bowels, and at proper intervals the patient must be told to make water, since the intense listlessness of the patient may lead him to fail to do so. Sometimes the water requires to be drawn off. High fever should be controlled by repeated cold sponging, or an occasional cold pack or cold bath (p. 510), and the general management of fever cases as discussed in detail on p. 508 is wholly applicable to cases of typhus. *The patient must never be left unwatched.* Delirium, which sometimes needs restraint, is to be met mainly by quiet, darkening the room, and applying cold cloths to the head. Stimulants, though not always necessary, are sometimes of great use towards the end of the second week, when the weakness is extreme, specially if the pulse is very fast and weak. They are doing good if the pulse becomes less frequent and stronger. The best stimulant is perhaps wine, to be given, in tea-spoonful doses at intervals, to the extent of two wine-glassfuls in twenty-four hours, or brandy or whisky in milk, half a wine-glassful to be mixed with a breakfast-cupful of milk, and given in doses of two or three tea-spoonfuls at a time, the whole cupful to be given in twenty-four hours. If cough, spit, and increased difficulty of breathing indicate congestion of the lungs, stimulants are to be used in this way. Twice the quantity noted may, in such a case, be given in twenty-four hours if it seems doing good. During the period of extreme weakness the attendant must guard against bed-sores by keeping the patient scrupulously clean, and by changing his position occasionally, so as to prevent the same parts being constantly pressed upon. During recovery strength is to be aided, not by stimulants, but by careful nursing and feeding, frequent small quantities of nourishing beef-tea, soups, &c., being given.

Typhoid Fever (*Enteric Fever — Intestinal Fever—Bilious Fever—Gastric Fever*).—Up till 1840 two fevers were confounded under the term *typhus* fever, but that two essentially different diseases were included under the one name was pointed out at the time mentioned by Dr. A. P. Stewart. Later a complete distinction was drawn between the two by Dr. William Jenner; the one described in the preceding paragraphs retained the name typhus, and to the other, because it was very like typhus in many particulars, the name *typhoid* was given. This fever (typhoid) is accompanied by serious disease of the bowel, and consequently to it the name enteric fever (from *enteron*, Greek for the bowel) has been given by some who do not like the confusion that two words so like one another as typhus and typhoid may occasion. The phrase "intestinal fever" is thus simply another phrase for "enteric" fever. Further, this fever is marked by sickness and by very decided diarrhœa or looseness of the bowels, and thus, as the symptoms marked out the stomach and bowels as the chief seats of the disturbance, the name **gastric fever** has also been used for it. This term is essentially a bad one. Typhoid fever is an extremely serious and a very commonly fatal disease, but there may be many disturbances of the stomach, accompanied by fever, but attended by no risk, to which the term "gastric fever" might be applied by some. It is a matter of the utmost moment that wherever typhoid fever exists it should be discovered; and the use of any term that would in any way tend to disarm suspicion as to the true nature of the disease is undesirable. Typhoid fever is often accompanied by severe vomiting, in which bilious matters are vomited, and hence some have called it **bilious fever.**

The **cause** of typhoid fever is a living organism or germ, such as have been described on p. 495. In the vast majority of cases it gains entrance to the body in food or drink. It multiplies in the bowel, finds its way into the blood, and by it to other organs, and is given off in the discharges from the bowel and bladder. If these discharges be not disinfected they may infect wells, streams, lochs, &c., and thus the disease spreads. But the infection is not cast off in the patient's breath or by the skin, like measles or scarlet fever and small-pox. These facts are of immense practical importance, since they show that a person may attend on a case of typhoid fever without fear, if care be taken that all discharges from the patient, and all linen soiled with them, are carefully disinfected.

Typhoid fever may occur at any age, though



PORTION OF A TEMPERATURE CHART IN A CASE OF TYPHOID FEVER (ENTERIC)

The chart records the temperature every two hours, from the 23rd to the 26th day of the disease.

On the 25th day bleeding from ulceration of the bowel began, the outbreaks of hæmorrhage being accompanied by marked falls in the temperature. So that the temperature gave warning of what was happening, even before the stools showed the presence of blood.

The chart shows how the margin may be utilized to record the instructions to the nurse. This chart might be used to record the temperature every hour, the lines marking off the spaces being used for the odd hours.

it becomes less frequent as age advances. No class or condition of men is free from its attack. It is most frequent in warm seasons of the year, and least frequent during cold weather.

It appears that some persons are able to resist the typhoid fever poison much more successfully than others, so that not only must the poison be introduced into a person's body, but the person must be in a favourable condition for its growth within him. A lowered state of general health is undoubtedly one of the most favourable conditions for the attack of this disease as of many others. While one attack of the disease seems to afford some protection against a second, many second attacks have been recorded.

Symptoms.—It is uncertain what time elapses between the period of the introduction of the poison into the body and the commencement of the disease. It appears to be about three weeks. The disease usually begins by the person feeling unwell and losing appetite. The loss of strength and general feebleness are marked. He complains of feeling chilly, and then of feverish turns, of being drowsy, troubled with headaches, and of restless sleep at night. These are all vague general symptoms. But there are also disorders of the stomach and bowels, vomiting and looseness, and bleeding at the nose is not uncommon. These are often the most striking symptoms, and should make one suspicious. The temperature of the person should be taken. It will be found higher than usual (see p. 507). The pulse will be found fast, and the tongue coated and brownish down the centre. One symptom should be sought for. It is pain on pressure in the right groin. If one presses this part with the fingers, generally gurgling will be felt, and the patient complains of some degree of pain.

In a typical case the chief symptoms are (1) a fever of a peculiar character, (2) looseness of the bowels, and (3) a rash of rose-coloured spots on the skin. In such a typical case the fever begins to abate in the third week of the disease, and has disappeared about the twenty-eighth day. Its peculiarity is that it is always a degree or two lower in the morning than in the evening. During the first week the temperature, as taken by the thermometer (p. 38), is each day higher than the preceding, that is, it rises to a greater height each succeeding evening and falls less each morning; during the second week it keeps each day about the same level, though showing the morning fall and evening rise, and during the third week it shows a daily descent. If the temperatures be marked on a chart, the first week shows a series of ascending steps, the second week shows a series of daily rise and fall at the same general level, and the third week shows a series of descending steps. This behaviour of the temperature in typhoid fever is the most characteristic feature of the disease, and serves to mark it off from other diseases though every other symptom fails. The rash comes out in the second week of the disease. It consists of rose-coloured spots about the size of a pin's head, raised above the skin, found principally on the chest, belly, and back. (They are represented on Plate XXVII.) They come out, only two or three at a time, in crops, and they fade in three or four days. But one crop succeeds another, till the end of the third week. At this period (the second week) the tenderness of the belly and looseness of bowels are more marked. The motions may be very frequent and resembling pea-soup. The other symptoms continue, and the tongue is dry and tends to crack on the surface. Towards the end of the second week the tongue is more dry and brown, pulse faster and more feeble, the person grows dull and listless, is very prostrate, and there is delirium. The delirium may be violent, or simply rambling, or muttering. In the course of the third week the weakness becomes excessive, and bed-sores are apt to form. The patient tends to slip down in bed. The body is wasted, the lips trembling, the pulse is extremely feeble and quick. Irregular starting of the limbs occurs, and the hands wander aimlessly about, picking at the bed-clothes. Blood is frequently passed in the stools. If the case is going to end in death, the starting of the limbs and wandering of the hands are marked, the motions and water are passed unconsciously in bed, and stupor comes on. A favourable turn is indicated by a gradual fall in the fever, a less frequent and more distinct pulse, a passing off of delirium, cleaning of tongue, and stoppage of looseness of the bowels. Recovery is always gradual and very slow. Many months may occur before strength is re-established. Relapses are not uncommon, attended by rash and all the other symptoms of the disease. They occur usually about ten days after the disappearance of the fever of the first attack.

While the symptoms that have been described are those of a typical case of typhoid fever, it must be observed that cases are very numerous where the symptoms are very obscure, and where, in consequence, the disease is apt to be overlooked. A patient, for example, may complain of chilliness and feverishness, of headache and unaccountable weariedness, of loss of appetite, and sleeplessness at night, and may exhibit no marked looseness of bowels, no spots on the skin, and no symptom pointing out typhoid fever with any certainty, while it is this disease which is attacking him. Constipation in typhoid fever is not so uncommon as is supposed. He may fight against his feelings of illness for seven or eight days, and then speedily succumb to the disease. Perhaps some great and sudden discharge of blood from the bowels occurs, or other grave sign of the mischief going on in the bowels. In all such cases the vagueness of the symptoms must not be allowed to make one indifferent. If the temperature is taken as advised (p. 507) it will probably give such warning as ought to lead to the person being sent to bed and being carefully nursed and watched. Such difficulties of diagnosis are now got over by testing the blood in a particular way for the presence of the typhoid organism—Widal's reaction.

The **complications** of typhoid fever are numerous. The looseness of bowels indicates serious mischief there. The bowels are the seat of patches of ulceration occurring in the position of the glands of Peyer (p. 199). In the process of ulceration a blood-vessel may be opened and fatal loss of blood may occur. The bursting of the vessel may be due also to improper exertion or to the taking of some hard food. In severe cases the blood is passed unaltered or in clots. Usually it is altered and makes the motions black, tarry-looking, and offensive. Where the loss is sudden and great it is known by the sudden paleness of the patient, failure of the pulse, and fainting (Plate XXIX.). Bleeding may occur between the middle of the second and the end of the fourth weeks. Another danger is that the ulceration may eat through the bowel wall into the cavity of the belly, and there set up fatal inflammation (peritonitis, p. 265). It is indicated by rapid swelling of the belly, violent pain, vomiting, great anxiety of the patient, and extreme frequency and feebleness of pulse. This occurrence is most common in the third, fourth, and fifth weeks of the disease.

Congestion and inflammation of the lungs are also exceedingly common.

Treatment. — Many cases of typhoid fever present no marked symptoms. Nevertheless every suspicious case must be treated with watchfulness, and the mild cases with the same care as the severe. The patient should be put to bed and kept there. Often a person feels so comparatively well in the morning that he wishes to get up for a little. *This must on no account be permitted.* The patient should be daily sponged with lukewarm water, and the body and bed-linen must be kept clean and dry and frequently renewed.

Perhaps the most important thing in the treatment of the case is the dieting. Milk should be the only diet, given raw, or boiled if there is diarrhœa, and with the addition of ice or lime-water or aerated water, and where there is digestive difficulty it should be peptonized (see p. 137, Vol. II.). From 1½ to 3 or 4 pints daily, according to age, is a suitable quantity. If white, curdy pieces appear in the motions, the milk should be reduced in amount or peptonized, as those pieces will irritate the bowel. *It is always best not to permit the patient to have much at one time, but to give small quantities often.* Thirst afflicts the patient, and ordinary water in moderate quantities is not to be refused. Barley-water may also be given, and water made slightly acid with dilute sulphuric acid or ordinary vinegar.

As regards drugs, opening medicines must be cautiously given. At the very beginning a good dose of castor-oil should be administered. The ulceration going on in the bowel must be remembered, and if, later, the bowels require relief, it is best to give an injection of soapy or plain water. Looseness of the bowels, if excessive, is to be checked by the catechu and chalk mixture, with the addition of laudanum, if necessary, to a grown-up person. (See PRESCRIPTIONS—CHALK MIXTURE.) Bleeding from the bowels is restrained by a half to one tea-spoonful of liquid extract of ergot (spurred rye) if it is obtainable, to be given every two or three hours, as long as required. Failing that, 10 to 15 drops of turpentine every three or four hours, for several doses, may be given in a little olive-oil. Turpentine, indeed, is an excellent drug given all through the disease, 2 to 5 drops in a half to one tea-spoonful of olive-oil thrice daily. It corrects the fetor of the motions, and tends to prevent bleeding. Dilute sulphuric acid (10–15 drops) may also be given instead of these. If pain and swelling of the belly occur, the remedy is laudanum, 10 drops in water, repeated every two or three hours, to keep down pain. As to stimulants, they are never to be given as a matter of course. They are valuable only in the later stages of the disease when weakness is excessive, the pulse exceedingly feeble, &c. In such a case whisky or brandy is the best. It should be given in the following way:—A wine-glassful of whisky is mixed with a breakfast-cupful of milk. Three or four tea-spoonfuls of the mixture are given at such intervals that the total quantity is not all used up for twenty-four hours. In extreme cases double this quantity may be necessary. But it should always be given in the way described, as thus one knows exactly how much is being given. The vessel containing the whisky and milk should, of course, be kept covered.

The great question, however, is how to prevent the fever running too high. Each case must be judged on its merits, but the modern view is that, if it runs up to 103°, something must be done to prevent it going higher. This may be done by the use of cold water in one or other of several ways—the various ways described on p. 510. The cold pack is more efficacious than cold sponging, and the full cold bath is much advocated in Germany and in America, where it is called the Brand bath. The bath is brought to the bedside, the patient is lowered into it naked, is kept in 10 to 15 minutes, during which time every part of the body, *except the lower part of the abdomen*, is gently rubbed successively. The temperature of the water varies, according to the case, from 90° to 65° Fahr. The detailed directions for treatment of fever laid down on p. 507 and the succeeding pages are applicable to typhoid.

For weeks after the disappearance of the fever great care is necessary. Even in mild cases the person should on no account be allowed to sit up till a week after complete disappearance of fever, as shown by thermometer (p. 38). Even weeks after apparent recovery, improper exercise or improper food may lead to serious mischief in the bowel. All hard food should therefore be avoided for weeks after recovery.

Typhoid fever may be communicated by the discharges from the patient, long after the patient's recovery, because the organism continues to inhabit the bowel. Such persons are called **typhoid carriers**.

Care must be taken to disinfect the discharges in the manner described on p. 516. All linen must be disinfected. In the country special pains must be taken that the discharges do not find their way into wells or burns from which a water-supply is taken. In this way contagion is spread.

Inoculation against typhoid fever is now practised, and should be submitted to by anyone going to live where the disease is common. It consists in the injection under the skin of an anti-typhoid vaccine. Two doses are given, the second ten days after the first.

There are two varieties of fever, strongly resembling typhoid, and only of recent years distinguishable from it by special tests, called **Paratyphoid A** and **Paratyphoid B**. The inoculation used should be a vaccine for all three.

DANDY-FEVER.

Dandy-fever (*Dengue—Three-day Fever—Break-bone Fever*).—This is an infectious fever, not known in Great Britain, but occurring in India, Burmah, Egypt, Persia, North and South America, and the West Indies. It attacks persons of both sexes and of all ages.

Symptoms.—The fever presents symptoms resembling rheumatic fever, scarlet fever, and ague. It often begins suddenly with severe pain in some joint, specially a finger-joint. The pain jumps from one joint to another, soon attacking many. There are high fever with shiverings, loss of appetite, great weariness, sickness, and pain in the head and eyeballs. The rash comes out on the third day, and is like that of scarlet fever, the face being red and puffy, the throat red and sore, the eyes red, and a general redness being over the body. It is usually accompanied by itching. The pulse is frequent, breathing is quick, and the tongue is covered with a white coating out of which red points project. On the fifth or sixth day the rash passes off, and the fever falls, and comparative health is restored. This lasts, however, only for from two to four days, when the fever returns, and a second rash resembling measles or nettle-rash (p. 420) appears. The second attack lasts two or three days and gradually passes off, much of the scarf-skin often separating. Though the fever passes off, the pain and swelling of the joints, especially of the smaller ones, remain, and may continue to afflict the patient for weeks. Further, more than a second relapse may occur, making recovery slow and doubtful. In ordinary cases, however, eight days is the average length of the disease. In the course of the fever delirium, in children convulsions, may occur.

Treatment.—Gentle movement of the bowels should be regularly obtained, but there should be no purging. The ammonia and ether mixture (see p. 511) should be given in tea-spoonful doses every two or three hours. The addition of tincture of belladonna is recommended, and two or three doses of from 5 to 10 drops may be given at intervals of an hour, the mixture being afterwards given alone. If the fever runs very high, cold sponging is useful. The joints may be rubbed with opodeldoc (soap and opium liniment) or with a liniment of opium, chloroform, and belladonna. During recovery quinine tonics are of great help. The following may be used:—

Quinine, ...	16 grains.
Dilute sulphuric acid, ...	$2\frac{1}{2}$ drachms.
Infusion of calumba,	to make 8 ounces.

Of this a tea-spoonful should be taken in a wine-glassful of water three or four times daily.

Food should be mild and nourishing, milk, light soups, rice, &c., and often change of air is very valuable in getting rid of the lingering affection of the joints.

INFECTIOUS FEVERS WITHOUT RASH (ERUPTION).

INFLUENZA.

Influenza (*Epidemic Catarrh—The Grip*).—This is an affection similar in its general characters to the disease described as catarrh (p. 214) or common cold-in-the-head. Indeed, to cold-in-the-head, when accompanied by sharp fever, pains in the bones, and sickness, the name influenza is often applied. The true influenza is, however, remarkably infectious, which common catarrh never is. In fact, influenza is one of the most remarkable of epidemic diseases, capable of running through a whole community with marvellous rapidity. Thus one epidemic of it, in 1782, spread over all Europe, missing no country of it, affecting more than half of the people, and killing many. Many epidemics of it have occurred since then. The infection is due to an organism conveyed by the air, which flourishes in the blood of the patient and is abundant in the spit.

Its **symptoms** begin with fever, pain in the head and eyeballs, a feeling of general soreness, and severe pain in the back and limbs. Its attack is very sudden, and is accompanied by great depression of spirits, general weakness, and frequently great weakness of the heart. There is usually some soreness of throat, which is unduly red, but not greatly swollen, and the eyes are red and tender. The tongue may be at first quite clean, but the sickness and vomiting of ordinary catarrh are usually absent. The chief features are the sudden onset, high fever, great prostration and intense headache, and pain in back and limbs. Complications are common, specially if the patient has not at once been confined to bed. The usual complication is catarrh of the air-passages, with cough and pain in the chest, or pneumonia, or catarrh of the bowels, or the complication may be of a nervous type with a tendency to neuralgic pains, delirium or stupor. A number of blebs occur on the lips very often. In about three or seven days the attack passes off, usually with free sweating, leaving the patient extremely weak and afflicted with troublesome cough. It is usually from such complications that death occurs.

The influenzal poison has a special tendency to attack the heart and leave a degree of heart weakness. One attack seems to make a person rather more than less liable to a second.

Treatment.—The patient must be kept in bed in a room kept at a moderate and regular warmth. Nourishing but easily digested food should be given frequently, and nothing is better than a tumblerful of hot milk and a breakfast cup of hot clear soup given alternately every two hours, that is each is given every four hours. To the milk, if prostration is great, a dessert-spoonful of whisky may be added. Sips of plain or aerated water may be given for thirst. If the hot milk is disliked, or stomach symptoms are present, the milk may be given cold or iced, but only in sips.

The patient usually demands relief for the aching head and back. This will infallibly be relieved by 10 grains antipyrin with 10 drops of laudanum and 1 grain citrate of caffein, if given early. The author usually gives a second similar dose one hour after the first, and a third four hours after the second. A fourth dose in 24 hours and a fifth 6 hours later will usually be sufficient; but only to an adult. To a child 2 grains antipyrin in 15 drops liquor acetate of ammonia and a dessert-spoonful of water, repeated every three hours for four doses.

For several days after the fever and pain have disappeared, the patient should be kept in bed, getting small quantities of nourishing food frequently, till full diet is restored. A tonic of quinine and iron helps the restoration to health and strength.

Hay-fever is described on p. 367.

WHOOPING-COUGH.

Whooping-Cough.—This is specially a disease of children, though grown-up people may also be affected with it. Girls suffer more than boys. It is extremely common in children, standing next to scarlet fever as a cause of death. The greatest number of cases occurs in children under eight years of age, and it is more fatal in spring and autumn than at other seasons of the year. It is the most fatal of all diseases to children under one year of age, and three-fourths of all the deaths from it are of children under two years, while only six per cent of the deaths occur above five years. It is, therefore, a disease from which children under five years of age should be most carefully guarded. *It is an infectious disease,* the cause of the disease being given off in the breath of the person suffering from it, and being capable of conveyance by the air and by clothes also. It is specially infectious in the early period of the attack. One attack almost perfectly protects against another. Now taking these two facts together—the terribly fatal character of the disease among young children, and its extremely infectious nature,—how great should be the care taken by mothers and nurses to prevent its spread and to protect their children from it? Yet it is the commonest thing possible to find mothers carrying children affected by it in public conveyances; and very insufficient pains are taken, when it appears in a household, to separate the affected child from the others.

Symptoms.—The earliest symptoms are like those of a common cold, with considerable fever. They begin probably a fortnight after infection has been received. The child is restless and feverish, pale and without appetite. Its breathing is quickened. It sneezes and has an irritable cough. The cough is very troublesome day and night, but specially at night. Fits of coughing come on; a quick short series of coughs ends in a long-drawn whistling breath, followed by another long cough. Some defluxion may be expelled at the end of the fit of coughing, and vomiting often occurs. After a week or a fortnight the fever lessens and the cough begins to be marked by the peculiar whoop, that gives the name to the disease. The cough still comes on in fits or paroxysms, in ordinary cases every hour, in severe cases every half-hour, and in bad cases even oftener. The child knows when it is going to come on by a tickling sensation. It becomes quiet and frightened, rushes to its mother or nurse, rises if it is lying down. The fit begins with a deep indrawn breath, which is followed by a rapid series of short coughs, becoming weaker, till all air seems driven out of the chest; the face becomes swollen and bluish; the veins are seen full of blood; the eyes are starting, the skin wet with sweat; the child seems on the point of choking, when the spasm, preventing the entrance of air into the lungs, begins slowly to yield, and as the air enters the narrowed opening in the windpipe it produces a long, whistling or crowing sound, the "whoop" of the disease. Two or three such attacks may occur quickly after one another, till the child is quite exhausted and faint. Often some defluxion is expelled towards the end of the attack, and vomiting is produced. The great strain on the blood-vessels may cause bleeding from the nose or other parts of the air-passages, and the eyes may become blood-shot. The child soon recovers and seems all right till another fit of coughing occurs. This stage lasts from four to six weeks or even longer, though sometimes it may be only two weeks, and then the spasms become fewer and less severe and defluxion is more free. Recovery is slow, and may often take many months.

The dangers of whooping-cough are the occurrence of bronchitis, of inflammation of the lungs, and of convulsions. The younger the child the greater is the risk of bronchitis rapidly overspreading both lungs. Without such complications recovery ought to take place, though death may occur during the spasm.

Treatment.—The child should be kept in a room constantly maintained at a moderate degree of heat. The air should be kept moist by steam from a kettle on the fire. The child should be clothed in flannel, and should get light nourishing food in small quantities often. The bowels should be kept regular by castor-oil or syrup of senna. The medicine to be given is bromide of ammonium and belladonna. Children stand large doses of belladonna, and the quantity may, therefore, be steadily increased in the following way: Let a mixture be made containing 64 grains of bromide of ammonium in 1 ounce of simple syrup (solution of sugar) and 3 ounces of water. Give a tea-spoonful of this every two or three hours. This is to be continued throughout the first week, and to it occasionally may be added four or five drops of ipecacuanha wine. When the second stage comes on, the same solution of bromide of ammonium is to be used, and to each tea-spoonful, as it is about to be given, add three drops of tincture of belladonna. If the child stands this quantity well, after one or two days' experience, five drops of the tincture may be added to each dose, and after a further experience of a day or two with the five-drop dose, seven drops may be added to each dose, and even ten drops. As soon as the black of the eye appears very large, no further increase in the quantity of belladonna is to be made. The object of the belladonna is to relieve the spasms of coughing, and, as soon as they begin to yield, the quantity of belladonna is to be gradually diminished. To help recovery of strength, when the disease is evidently over, nothing is so useful as change of air. This should not be sooner than six weeks after the commencement of the illness. As a tonic to aid recovery, a half to a tea-spoonful dose, according to age, of syrup iodide of iron may be given thrice daily. Disinfection should be practised as described on pp. 516 and 517.

DIPHTHERIA AND CROUP.

These two diseases will be considered together, since they are the same disease—called diphtheria when it principally attacks the tonsils and parts in their neighbourhood, and called croup when it principally attacks the top of the windpipe—the larynx (p. 354).

Diphtheria is a contagious disease, the result of the introduction into the body of a particular organism (p. 502). The poison may be harboured on clothes, and so carried about and spread. In some places it is more or less constantly present, probably because of some bad sanitary condition. It occurs in every climate and season. It may attack persons of any age, but is most common between the ages of two and ten years. It seems to have some relationship to scarlet fever, for in many cases diphtheria occurs after scarlet fever.

Symptoms.—The disease begins to show itself within a few days after the poison has been received into the body. But the symptoms may be so ill-defined and vague that the disease is far advanced before the patient really appears seriously ill. The symptoms at the commencement are chills and feverishness, loss of appetite, general weakness and dulness, and marked paleness of skin. Sometimes in the child the first thing that attracts attention is a complaint of soreness of throat. The exact nature of the ailment may be made certain by microscopic detection of the organism in the phlegm or membrane removed from the throat. When the throat is examined, already there may be seen the presence of white patches that too surely indicate the nature of the disease. These are patches of false membrane, of a dull white or gray colour, like pieces of wash-leather. They are placed on the tonsils and neighbouring parts of the back of the throat. The patches are small to begin with, but they tend to spread, so that in severe cases the whole back of the throat, including tonsils and uvula (p. 195), is covered with the membrane. If the membrane be scraped it separates in shreds, but grows on again. The throat is also considerably swollen; indeed, even though only one side is attacked, the swelling may be so great as almost quite to block the passage. The glands at the side of the jaw are also swollen. As a result of the swelling there is difficulty of swallowing, though the attempt to swallow does not produce the intense pain common in a severe attack of quinsy (p. 216). In many cases swallowing can be performed all through the illness. The swelling and loss of appetite combined render the patient not inclined to take food, and in children this is a cause of much trouble. For a marked feature of the disease is the excessive prostration it produces. It is to combat this that remedies are, from the first, directed; and so where disinclination to swallow exists, there is great difficulty in getting sufficient food taken to maintain the strength. The disease may not go beyond the stage described, and in ten days or a fortnight recovery begins, the membrane separating in pieces, and being spat out, or, in young children, swallowed. The breath is frequently very foul, because of the decomposition of the false membrane. Even after the throat is quite clear and clean, the patient remains extremely feeble, and in some cases the voice is altered, perhaps lost for a time, owing to paralysis.

But the membrane may extend up into the back of the nostrils, and be evidenced by stopping of the nostrils and discharge of matter and blood; and it may pass down the gullet towards the stomach. Thus the disease may be so prolonged that the patient dies of exhaustion.

A most frequent and the most fatal form of the disease is that in which the formation of the false membrane proceeds downwards into the windpipe. The symptoms of this occurrence are those of **croup.** The voice is hoarse and there is a short dry cough of a peculiar character. It is hoarse and muffled, "like the distant barking of a puppy." Sometimes it is a brassy sound. Accompanying the progress of the disease down the windpipe there is increasing difficulty of breathing. These signs are of the most serious nature, especially so in children, in whom the passage of the windpipe is narrow and easily blocked. As the membrane thickens the voice is lost, and the cough becomes muffled and almost noiseless. Suffocative fits come on, partly due to spasm, partly to the membrane blocking the air-passage, and the patient struggles for breath, the face becoming blue and the eyes staring. One fit passes off, and the patient becomes easier, but speedily another comes on, the person at last sinks into a state of exhaustion and stupor, and death occurs. Usually the end happens before the fourth or fifth day after the symptoms began.

Sometimes the disease attacks the air-passage only, without any previous attack of the tonsils, no white patches being seen at the back of the throat. In very young children the formation of the membrane in the windpipe may proceed so quickly that death occurs within a few hours of the hoarseness and cough indicating the disease.

Further, there are cases of diphtheria in which death occurs within a few days, even in grown-up persons, not from suffocation, but from the violence of the poison. Indeed death may occur without any apparent formation of membrane, and so rapidly as to leave some doubt regarding the true nature of the disease.

Nor yet is all danger passed when the throat affection has passed away, for death may even then suddenly occur from loss of blood, failure of the heart, and other causes.

Treatment.—The person is to be put to bed in a large well-ventilated room, which must be kept continually at a moderate heat, and in which no draughts must be permitted. A fire must be kept on constantly, and a kettle should always be on the fire pouring its steam into the room. If the least suspicion of the throat being affected is present, the kettle should be a bronchitis kettle (see Plate XXXI.—APPLIANCES FOR THE NURSERY), and the steam should be plentifully poured in the immediate neighbourhood of the bed. If the bowels are confined, castor-oil must be given, or an injection. From the beginning every effort should be directed to maintain the strength, sips of warm milk or warm beef-tea, strong mutton-broth freed from fat and vegetables, eggs beat up in milk, &c., should be administered in small quantities often. Port wine in small quantities is also to be frequently administered. Cold drinks are not to be withheld, and ice may be given to suck. When the patient cannot swallow, nourishing injections become necessary. The method of administering them is explained in another part of this work. (Refer to index for INJECTIONS.)

Diphtheria is now cut short, the growth of the membrane arrested, and the disease cured in a few days by the injection under the skin of diphtheria antitoxin or diphtheritic serum (see p. 514). When this method is not at hand, the treatment by medicine is twofold. The throat must be regularly painted several times daily, in the hope of arresting the growth of the false membrane, and a mixture is to be given. The paint is made of equal parts of glycerine and liquor of perchloride of iron—the strong liquor. To each ounce of this 1 drachm of sulphurous acid is added, and the whole shaken together. A brush is used — camel's hair or goose quill—firmly set on a long handle. The tongue of the patient is held down by a spoon, and the back of the throat thoroughly painted over. The painting must be repeated twice or thrice daily. With children it is difficult to accomplish, and help is necessary. The following mixture is to be given:—

Chlorate of potash in powder,......	120 grains.
Solution of dialysed iron, ...	½ ounce.
Syrup of orange,...........................	1 ounce.
Water,......................................	to 4 ounces.

Of this from a half to one tea-spoonful is to be given four or five times daily. When suffocation is threatened steam is to be kept streaming about the bed, and hot cloths may be applied on the neck. A surgeon would probably suggest opening the windpipe by the operation known as tracheotomy (p 363). During recovery quinine and iron tonics, nourishing foods, cod-liver oil, and, when the patient can bear it, removal to the sea-side, are valuable aids to full restoration of health.

Disinfection (p. 516) must not be forgotten.

Croup, true croup, has been considered in the preceding paragraphs as an extension of diphtheria down into the top of the windpipe—the larynx (p. 354), or into the windpipe itself; or it may be the diphtheria attacks the larynx and windpipe first and directly. There is, however, an ordinary inflammation of the top of the windpipe and windpipe itself, not attended by formation of false membrane, to which children, of two and three years old, are specially liable, to which the term croup is also applied.

Its symptoms may come on suddenly with alteration of voice, some hoarseness, and frequent dry short cough. The cough speedily takes on special characters, it becomes barking and "brassy." There is fever, with difficult and hurried breathing, crowing and piping noise with taking in of breath, quick pulse, and the child is restless and anxious and plucks at its throat. It may be impossible to say whether the symptoms are due to the formation of a false membrane in the windpipe, as in diphtheria, or to inflammatory swelling. Death may rapidly occur by suffocation or exhaustion.

Croupy symptoms are often present at the commencement of measles.

The treatment is the same as that described on p. 362 for inflammation of the larynx.

RELAPSING FEVER.

Relapsing Fever (*Famine Fever — Bilious Remittent Fever—Seven-day Fever—Irish Fever*).—This is a fever that seems to be related to periods when extreme poverty prevails, hence its term famine fever. So far as Great Britain is concerned, it came from Ireland, and hence was called Irish fever; but it has also appeared in America, India, Africa, and Russia.

It is undoubtedly due to the presence of a living germ in the blood—the spirillum of Obermeyer,—is contagious, and may be carried long distances by infected persons and by clothes.

Symptoms. — It is doubtful what period passes after the poison has been introduced into the body before the attack begins, sometimes apparently only a few days, at other times about a fortnight. The attack begins with shivering fits, pain in the forehead, back, and limbs, high fever, and great dryness of skin. Appetite is lost; there is thirst; the pulse is very fast; the tongue is covered with a thick white coating, the tip and edges being red. The bowels are confined; there is pain over the stomach, and to the right side over the liver; and vomiting occurs. Jaundice, yellowness of the skin, occasionally appears about the second or third day, hence the idea that the fever is a bilious one. The spleen and liver are enlarged and tender. Towards the end of the first week there may be delirium. In from five to seven days from the beginning of the attack the fever suddenly passes away, usually after copious sweating, lasting for a few hours, or after free discharge from the bowels. The other symptoms improve, but the patient is left weak. For about a week he remains apparently well, and then a second attack suddenly comes on, similar to the first, lasting about three days, and ending like the first. A third attack may follow. Purplish spots may appear during the disease, though there is no regular rash. There may be severe bleeding of the nose.

Deaths from relapsing fever are not common. Weakness produced by the fever is great, and recovery is slow. The complications apt to occur are affections of the lungs and bowels, looseness, and dysentery.

Treatment.—Light food of milk, corn-flour, beef-tea thickened with rice or corn-flour, is to be given in small quantities. Cold sponging, when the heat is great, with water containing a little vinegar, is refreshing. The patient may have ice to suck, and tea-spoonful doses of the following mixture are to be given every three hours:—

Solution of acetate of ammonia,.......	2 ounces.
Spirit of nitrous ether, ...	$\frac{3}{4}$ ounce.
Water, ...	to 4 ounces.

To relieve pains and help sleep 5 drops of laudanum may be added to each dose, *but only to grown-up persons.* The bowels should be moved by castor-oil or by injections. No medicine prevents the relapse. Recovery is to be aided by light nourishing foods and quinine tonics.

Disinfection (p. 516) must be practised.

PLAGUE.

Plague (*Bubonic Plague—Pestilence—The Pest—Black Death*).—This is a disease believed to have been observed as early as the second century before Christ. It was common in Egypt, other parts of Africa, and Asia. In the sixth century after Christ it spread over Europe. From that time it continued to exist in Europe, breaking out at intervals in fierce epidemics. Towards the end of the seventeenth century it began to disappear from Europe, from which, however, it had not quite departed till 1841. From 1665, the date of the Great Plague in London, the disease disappeared from Great Britain, and continued to be unknown in that country till 1900, when it reappeared in Glasgow, but was speedily extinguished by vigorous sanitary measures, having attacked 36, of whom 16 succumbed. It seems still to exist in Arabia, Persia, and other parts of Asia. Starvation, filth, and overcrowding are the conditions that favour its spread. It is extremely contagious, and may be inhaled in dust and carried about by clothing.

Rats are very susceptible to the infection, and active agents in its propagation. The fleas which infest a sick rat, and leave it when dead, may by their bite communicate the disease to man. The infection is an organism—a bacillus, which can be artificially reared. It is immediately destroyed by a solution of bichloride of mercury of the strength of 1 per 1000.

Symptoms.—The disease appears about five days after infection. It begins with shivering, with fever, pain in the forehead, back, and limbs, and great weakness of body. The patient wears a dull, stupefied, haggard look. From the second to the fourth day of the disease swellings of glands (buboes) appear at the angles of the jaws, in the armpit and groins. The eyes are red, skin hot, tongue as if covered with wool, or dry, black, and cracked. The gland swellings cause pain, and come to matter if the patient does not die before.

The majority of deaths occur within four or five days. The death-rate is not less than one in three.

Treatment is by the injection of an anti-toxin (p. 514), Yersin's, and, during an epidemic of plague, protection may be obtained by the use of Haffkine's protective inoculation.

YELLOW FEVER.

Yellow Fever (*Black Vomit—Yellow Jack*) is a disease of hot climates. Cold kills it. It is rarely absent from the West Indies, and is most fatal from May to August. It is due to an organism, but, like ague, is not communicable from person to person. The infection is carried by the common brindled or tiger mosquito (*culex*), by whose bite it is conveyed to the human being. The infection can be carried by clothing, and conveyed by infected ships. A person who has suffered from one attack is safe from a second.

The **symptoms** may appear within one or two days after the poison has entered the person's body, or may not occur for six or ten. The attack is sudden, beginning with shivering, fever, dry skin, intense headache, pain in the back and limbs. The eyes are glistening, bloodshot and red; the face is congested; there are great thirst, loss of appetite, tenderness over the stomach, sickness and vomiting. The tip and edges of the tongue are very bright red, the rest being covered with a white coat. The lips and throat are also bright red. The pulse is at first very fast, but may greatly diminish in speed, even while the fever remains high. The fever may not remain high for more than a day or two, but the vomiting and tenderness over the stomach continue. At first the vomit is of the contents of the stomach, then it becomes coloured with bile, and later has a "coffee-grounds" appearance, the black vomit, due to mixture of altered blood. The motions are often black for the same reason. By the second or third day of the disease the whites of the eyes may be seen to be yellowish, and the yellowness spreads to the face and over the body. The urine, which is at first clear and of the usual quantity, becomes, with the advance of the disease, of a deep yellow from the presence in it of bile. The colour may deepen to orange-red, and at the height of the attack almost no urine may be made. In favourable cases the quantity becomes large and the colour becomes very dark. Death may take place within a few hours of the attack, the person becoming collapsed. It may occur, owing to bleeding from stomach, bowels, or kidneys, or from heart failure, at any time in the progress of the disease, the fifth day being regarded as critical. Recovery is gradual, and the jaundice takes long to disappear. The death-rate is very high.

Treatment.—The patient should be confined to bed and all exertion strictly forbidden. The room should be large and well-aired, but kept constantly at a moderate warmth. The bowels should be relieved by injections. Corn-flour, beef-tea, chicken-broth, milk, and similar food should be given at regular and short intervals. Lemonade and barley-water are allowed. To allay sickness ice is to be sucked, and mustard poultices applied over the stomach. In cases of recovery the person must not be allowed to sit up till fourteen days have passed.

All discharges from the patient must be at once disinfected, as recommended on p. 516.

HYDROPHOBIA.

Hydrophobia (*Dog-Madness—Rabies*).—The word hydrophobia is derived from two Greek words, *hudōr*, water, and *phobos*, fear, the dread of swallowing and the spasms produced by the attempt being a marked feature of the disease. It is a disease to which dogs, cats, wolves, and foxes are liable. It is due to a particular poison, which seems specially to exist in the saliva or spit of the animal affected by the disease. It can only be produced in human beings by the direct introduction of this material into the body by a bite or other wound. A person may be bitten by a dog and may in consequence be seized with the disease, although the dog did not at the time show signs of the disease. Cases have been due to a dog, not known to be suffering from the disease, licking the hand of its master on which some slight wound was present. The bite of a cat may produce it. Probably, however, not more than a third of the persons bitten by mad dogs take hydrophobia, even when no attempt has been made to destroy any poison that may have been imparted from the dog's mouth. When the bite has been through clothes the risk is less than if the part of the body had been uncovered. More men suffer from the disease than women. There seems no doubt that a bite from a healthy dog cannot produce the disease. A dog must be suffering from the poison, whether it is evident or not, before it can impart the disease to another.

Symptoms.—It is very doubtful how long the poison requires to reside in the body before the disease appears. The shortest interval between the bite and symptoms has been about twelve days. The interval is seldom less than a month, and is on an average six or seven weeks. In some cases many months have passed before the disease appeared, and some have been recorded in which the interval extended to years. The appearance of the disease after four months is, however, seldom. The wound by which the poison gained admission to the body usually heals as easily as an ordinary wound. It is said that among the first symptoms in many cases is return of pain to the place of bite, hot tingling pain, shooting from the part. Such is often not present. Other symptoms are restlessness, shivering, uneasiness, a feeling of illness, disturbed sleep, lowness of spirits, and discomfort about the throat with some difficulty in swallowing liquids in particular, while at the same time there is thirst. As the disease advances the patient becomes excited, the eyes look wild, and he wears an expression of terror, and is liable to outbreaks of delirious excitement in which he may strive to injure himself or others. The chief symptom is the spasm that occurs on attempting to drink. At first it is mere difficulty of swallowing, but soon the attempt causes a spasm, a "catch in the breath," which, in the course of a few hours, becomes marked as a strong contraction of the muscles of breathing, there being a strong effort as in taking in a deep breath, so that the shoulders are raised and the corners of the mouth drawn outwards. The spit cannot be swallowed. It collects in considerable amount, and hangs thickly from the mouth, a source of great annoyance to the patient. Even when the patient is quite conscious, the impossibility of swallowing is marked. The person may take a glass of water, and, making up his mind with great effort, may carry it quickly to his mouth with agitation, but the spasm comes on and the glass is violently thrown away, and any water that may have got into the mouth is violently thrown out, while the patient shudders, and marked spasms of the muscles for breathing occur. The very thought of drinking is terrifying. The mere sound of running water produces spasm, and the state of terror and agitation is extreme. In advanced cases any sudden noise, or a rush of cold air, will bring on a convulsive attack. As the disease advances the patient becomes feeble, the voice hoarse, and the convulsions more frequent and severe. Death occurs from exhaustion or from suffocation in convulsion. The disease is without exception fatal, death occurring in from two to six days.

In dogs the symptoms of rabies are sullenness, fidgetiness, and continued shifting of position. The dog seems to see things in the air, which he gazes at, follows, and snaps at. His appetite is perverted. He swallows bits of coal, wood, &c. Saliva streams from his mouth, and hangs in sticky strings from it, disturbing him and causing constant efforts with paws to get rid of it. He makes a hawking noise in the effort to clear the throat and mouth. His bark is hoarse, and eyes bright. There is evidently intense thirst, and *the dog has no fear of water, for he often buries his muzzle in water at the height of the attack*; but he cannot drink owing to paralysis of muscles, or spasmodic irregular movements of them. He bites anything that comes in his way, and may thus in a short time infect other dogs, cats, and other animals. Finally the dog reels and staggers, his hind-legs and lower jaw lose their power, and he dies in convulsions or from exhaustion.

Treatment. — Whenever a person is bitten by a suspicious animal the circulation of blood ought at once to be stopped, for a brief period, in the bitten part, by tying a tight band, if it be a limb, above the bitten part, and carefully washing the bite and allowing it to bleed freely. As soon as possible—immediately, if possible—the part should be burned. A hot iron, poker, &c., may be freely and deeply used, or nitric acid painted lightly over the place with a brush, and then wiped off with a sponge and cold water. Attempts to treat the disease have failed. Attempts may be made with chloral hydrate, in from 10- to 30-grain doses, to keep down the spasms. The patient should be kept very quiet in a dark, still room. Persons in attendance ought to be careful, since a bite from a patient, or the spit of the patient cast on the attendant, may impart the disease.

Pasteur showed that the poison of hydrophobia was located in the spinal cord of rabid dogs, and he was able from the cord to make a preparation which, injected into a person who had been bitten, hindered the development of the disease. Institutes called Pasteur Institutes have since that discovery been erected in most countries for the treatment of persons suffering or likely to suffer from hydrophobia.

GLANDERS AND FARCY.

Glanders and Farcy are diseases of the horse and of animals of the same species. They may be communicated to man by the discharge from the nostrils of the diseased animals. It is, however, rare in man. The organism causing it has been discovered; and from cultures of it a substance is prepared—**mallein**—by the injection of which into animals the detection of glandered animals is secured.

Symptoms appear from three to eight days after the introduction of the poison, and in some cases after a longer interval. They are high fever, great heat of skin, shiverings, quick pulse, pains in muscles and joints of a rheumatic character, headache, sleeplessness, profuse sour sweatings and clamminess of skin. The nostrils become congested, and a biting, watery fluid comes from them, which soon becomes thick, and mattery. A rash, at first of red spots, like flea-bites, appears scattered over the face, limbs, neck, and belly. They become pimples like peas, grow yellow, and soon burst, pouring out matter, and leaving bad ulcers. The eyes yield matter; sores form in the mouth and throat, and the lungs become affected. Lumps, turning into boils, form in the skin on the face and in the neighbourhood of joints. The patient becomes very weak; delirium comes on, followed by stupor and death. The disease runs its course in sixteen days on an average, but some cases end fatally in a week. It is usually fatal.

In glanders the nose and ear-passages are early affected In farcy the poison is introduced in a wound on the body or limbs. The part becomes red and inflamed, glands in the neighbourhood become affected, and lumps (farcy-buds) and boils form in the skin. Both are, however, practically the same disease.

Treatment.—No curative treatment is known. The patient's strength must be maintained, as well as possible, by nourishing food and stimulants, and the affected parts should be carefully and regularly cleansed, abscesses opened and cleaned out, &c. A person attending a case ought to wear india-rubber gloves while bathing the affected parts.

SYPHILIS.

Syphilis (vulgarly called *Pox*) is a contagious disease, is, indeed, a type of that class of diseases capable of being contracted only by the direct introduction of a special poison into the body of a person. The poison is, in this case, communicated directly by sexual intercourse or indirectly by inheritance. To this rule there are, however, exceptions which will be noticed. How the disease first originated, where, that is to say, the first poison came from, it is impossible to state. It appears, however, to have occurred in Europe, and certain parts of Asia, from the earliest times. It has spread round the entire globe, by means of the commerce between countries, though some regions have escaped its attack. It is not affected by climate. During the latter part of the fifteenth century the disease assumed an epidemic form throughout the whole of Europe.

One attack of syphilis protects against a second, but then the disease does not run its course in the brief period occupied by other fevers, such as small-pox, scarlet fever, &c. Its progress occupies months, even years, and sometimes continues throughout the life of the person who has contracted it.

The disease is due to a spiral organism (see Vol. I., p. 496), described by Schaudinn in 1905, called **Treponema Pallidum**, or **spirochæta**; and where the diagnosis is doubtful it may now be made certain by the employment of a test, **Wassermann's**, which, however, requires the resources of a bacteriological laboratory.

Symptoms.—The fearful character of this disease will be best understood by an account of the progress of an ordinary untreated case.

The first occurrence of the disease is the appearance of a sore, called the **hard chancre**, at the place where the poison has been introduced, usually some part of the genital organs. This sore, however, does not appear for a considerable time after the poison has been received. There is a period, that is to say, corresponding to the period of incubation or hatching of ordinary fevers, which has been referred to on p. 518. This interval is on an average four weeks. It may be only a little over two weeks, while, on the other hand, it may extend to nearly six weeks. During this interval there is nothing whatever to lead the person who has exposed himself to the disease to suspect the possibility of its existence. A person whose conduct has rendered his infection only too probable, after failing to discover anything for a week or two, may conclude that he has (undeservedly) escaped, but this conclusion is not justified so early as this. The form which the sore takes on its first appearance is that of a small red dark-coloured pimple, which slowly grows larger. The person may be, and often is, unaware of its presence, since it is not painful nor itching. In a few days the pimple is broken by the separation of a part of the surface, and speedily a little ulcer is formed. The ulcer is of a peculiar character. It is not deep but shallow, and all round the sore is a firm ridge of a dark-red appearance. If the part be taken between finger and thumb it has a hard feeling, as if a little mass of gristle had been deeply imbedded in the substance of the skin. The ulcerated surface is grayish, and rather dry, only a scanty thin discharge being produced by it. In about six weeks it reaches its complete formation, when it is about the size of a split pea, and it thereafter begins to diminish. When it is healed it leaves a white scar that will never disappear. The scar is below the level of the surrounding parts, which are somewhat hardened, and of a darker colour than is usual. So little trouble does this sore occasion that the person may from first to last be ignorant of its existence. The sore is single; several of them do not occur on the same person. While this is the usual form and course of the sore, it may appear as a mere scratch or crack, healing easily and leaving scarcely any recognizable scar. What has been described is the true, hard chancre, the first result of the activity of the special poison of syphilis. But there is another sore, called soft chancre, or **chanchroid**, also the result of the introduction of a poison, obtained in the same way as the preceding, but which never gives rise to syphilis. It is described elsewhere (see INDEX). It is painful, pours out abundant discharge, is accompanied by inflammation and swelling, but has not the hard gristle-like feeling of the true chancre. Moreover, matter from the soft sore, getting into a scratch on any other part *of the same person's body*, will reproduce a similar sore; while, on the other hand, matter from the true chancre cannot produce a second sore on the same person, though it can produce a sore like that it came from on another person. One or two weeks after the appearance of the *true* chancre, the glands in the groin become affected. In fig. 130 on p. 285 is a representation of the glands in the groin. Those marked *d. e. f.* in the figure receive material from the genital organs, and if the poison of syphilis has been there introduced, it in time reaches the glands and affects them. They increase in size, not necessarily all of them, but several. The increase is slow and painless. On pressing with the finger they are felt to be hard and are freely movable in their positions. They may become as large as almond shells, and so they remain for years, not coming to matter, and giving rise to no trouble, but presenting almost conclusive evidence of the existence of syphilis. This is another distinguishing feature between hard and soft chancre, for the poison from a soft sore reaches the same glands, but causes in them inflammation and formation of matter, so that one or more buboes, as they are called, are produced, that is, abscesses, which are extremely stubborn and slow to heal.

And now there follow evidences that the poison has not only passed up from the spot where it was introduced, into lymphatic glands, but has gained entrance to the blood, and has affected the constitution. These evidences are called the **secondary symptoms** of syphilis, or briefly **secondaries.** The first of these is the appearance of a rash on the skin, which comes out in from six weeks to three months after infection, usually in about sixty or seventy days. The rash is at first of rosy red spots, which appear about the chest and belly, and may cover the whole body like a crop of measles. They soon become dull red or brown, and finally disappear, to be succeeded by pimples, which have a coppery colour. The pimples by and by fade, leaving copper-coloured stains in the skin, which take some time to disappear, but leave no scar. They begin on the trunk of the body, but spread to the arms and legs, and, unlike many ordinary skin affections, do not miss the palms of the hands and soles of the feet. They may come out in crops, off and on, for several months. Moreover, this rash of syphilis is capable of assuming many various forms; but, whatever the form, one great peculiarity is the coppery colour of the staining of the skin which attends it. The skin of the scalp is often affected, scales forming, and the hair loses its gloss, becomes dry, and tends to fall out, so that baldness may be produced.

Some amount of feverishness, loss of appetite, paleness, weakness, headache, and rheumatic-like pains, often very severe, are not uncommonly experienced just before the appearance of the rash.

On p. 413 it is explained that mucous membranes, the covering of red parts like the lips, inside of the mouth, throat, &c., are practically of the same structure as the skin. Hence it is not surprising that affections of the mucous membranes occur similar to those of the skin. The mouth and throat commonly suffer; the tonsils (p. 195) are liable to ulcerate, the nostrils and box of the windpipe sharing in the trouble. Raised patches about the corners of the mouth and anus (p. 189) are frequent.

Now it is certain that the matter that oozes from, or covers, these ulcers and raised patches is capable of communicating the disease. This is a fact of the utmost importance to observe. What it implies is this, that a person who has such syphilitic ulcers or patches in throat, or mouth, or tongue, is capable of communicating the disease by a kiss, if the slightest crack or fissure exists on the lip of the person kissed, by which the poison could enter. Moreover, for the same reason, a healthy person using, without cleansing, cups, tumblers, &c., that have been just previously used by a syphilitic person may contract the disease. Thus while at the beginning of these paragraphs on syphilis it has been said that the disease is usually contracted by impure sexual intercourse, it is not uncommon to find it, in perfectly innocent persons, acquired by such other ways as have been indicated. For example, a hard chancre on the lip is often seen. A child who has inherited syphilis from its parents may communicate it to its wet nurse during suckling, and a wet nurse by the same means may communicate it to a child. Besides the affections of skin and mucous membranes, mentioned as secondary symptoms of the disease, others are common. Serious inflammations of the eye—inflammation of the iris and of the retina and optic nerve (p. 482)—are quite ordinary results. Affections of bones and joints, indicated by severe pains of a rheumatic character, usually worse at night, are also frequent. The bone affections are commonly marked by the appearance of small painful lumps, usually on the shin bones, to which the term "nodes" is applied. In fact the diseases which may arise in the progress of the secondary stages of syphilis, due to the poison in the blood, are innumerable, and are only properly treated when their cause is recognized. This secondary stage lasts for from six to eighteen months, during which the general health of the patient is liable to serious disturbance and depression. At the end of that time the disease may disappear, even without treatment, and not again trouble the patient. Symptoms are, however, apt to show themselves now and again still indicative of the operation of the poison, such as the occurrence of skin diseases of various kinds, of ulcers, &c., which are obstinate, even refusing readily to yield to treatment.

Moreover, at a variable interval after the end of the secondary stage, what are called **tertiary symptoms** may reveal themselves. The chief evidence of the third stage is the formation of collections of inflammatory material in various parts of the body, in skin, mucous membranes, muscle, bone, liver, and other internal organs, brain, and spinal cord. These new growths are called **gummata**. These growths readily ulcerate and break down, causing destruction of the substance of the part in which they happen to be. They may disappear without ulceration, but still their disappearance is attended by destruction of the part in which they are lodged and consequent contraction of the part, shown by deep and permanent scars. In the skin the growths form flat elevated patches of a deep purplish-red colour, called syphilitic tubercles. Such destructive growths may form in the gullet, leading to contraction and difficulty of swallowing; in the box of the windpipe, attacking the vocal cords (p. 389) and causing hoarseness and loss of voice; in the nostrils, producing destruction of the gristly parts, giving rise to offensive discharge (STINKNOSE, p. 473), and ending in falling in of the bridge of the nose; and in many other parts may similar growths occur. Tumours may form in the brain, and may cause deafness, blindness, paralysis, and other symptoms dependent upon their position. Intense and persistent headaches continuing for weeks without intermission are extremely suspicious of syphilitic disease of the brain.

The consequence of such long-continued disease is a gradual but marked loss of general health and vigour, shown by sallowness of complexion and increasing thinness and loss of strength, so that the result of the disease is a miserable existence and a premature end.

Inherited Syphilis.—A husband may, of course, infect his wife. Syphilis is a very common cause of abortion, occurring usually about the fifth or sixth month of pregnancy. One miscarriage after another may thus be occasioned, each succeeding one may be at a later period than the one before, till after several abortions a child is born alive. A child may be born with, already at birth, signs of the disease. It is shrivelled, puny, and unhealthy looking, and speedily dies. Commonly, however, at birth the child is healthy looking, and the signs of the disease do not appear till three or four weeks later. A syphilitic child has sores, chaps, and cracks at the corners of the mouth, ulcers of the mouth, and is afflicted with snuffles, owing to similar affections of the nostrils. Little soft growths are found about its anus (p. 189), and a rosy rash about the buttocks and neighbouring parts is a most common sign. It is peevish and fretful; its skin is dry and withered-looking, its face old and weird-looking, its hair scanty, its body thin and wasted. These symptoms, if the child live, disappear about the end of the first year, but scars are left to mark the seat of the sores. In later life the bridge of the nose is sunken, the teeth have a pegged appearance, and the clear part of the eye (cornea) is liable to suffer from an inflammation that makes it cloudy and of a ground-glass appearance.

A child may inherit syphilis from either parent; but a curious fact is that the child of a syphilitic father may exhibit the disease which the mother has escaped. The father may, that is to say, infect the child without previous infection of the mother.

Treatment.—It may be stated as a general rule that, if proper treatment be adopted early in the disease and persisted in, and *if the patient be a person of temperate habits, and, above all things, if he abstain from habits of drinking*, the disease may be got rid of within two years of infection. In regard to children it may also be said that, provided the disease does not appear for several weeks after birth, *and if the child be properly fed and in every way well cared for*, proper treatment will effect a cure.

The general treatment consists in good nourishing food, moderate exercise, moderation in, indeed abstinence from, all liquors, perfect cleanliness, and moderate exercise in the open air. Frequent washing of the whole body with soap and water, and an occasional Turkish bath are of importance. Flannel should be worn next the skin, and care to avoid chills taken. The patient should continue his work or business to give mental occupation. Smoking should be entirely given up if the mouth or throat is ulcerated, otherwise it should always be moderate.

As regards special treatment, a brief statement may be given of the treatment of an ordinary case in its different stages; but wherever possible the patient should place himself in the hands of a qualified physician, and should scrupulously follow his every direction. As regards the chancre, it is doubtful whether any treatment by burning, &c., will destroy the risk of the constitutional disease arising. The sore readily heals if cleanliness and frequent bathing are practised. If the patient is anxious to have it destroyed, caustic should not be used, but strong nitric acid. A brush, moistened with the acid, is lightly brushed over only the crack or ulcer, sound skin being avoided, and the sore is then bathed with cold water. A healthy sore remains, when the slough, due to the burning, separates. It soon heals if kept clean by bathing. Often the secondary symptoms appear before the patient is aware of having contracted the disease, the chancre having been unnoticed. When they appear, or to avoid them if the chancre has been observed, the drug employed is mercury. Mercury has gained a bad reputation, because in former times it was improperly used. When properly used it is perfectly safe, and it is the only drug that can satisfactorily deal with the disease. When required when the secondary symptoms are slight, or used as a precaution, it may be given in pill according to the following prescriptions:—

Blue pill,................1 grain.
Extract of gentian,...1 grain

to be made into one pill. One such pill is to be taken after meals thrice daily. It is well, before taking the first pill, to clear out the bowels by a double strong seidlitz-powder. If the mouth and gums become sore the pill is to be taken less frequently—twice daily, for example—or its use may be stopped for a day or two and then resumed after another purge. If treatment is not begun till the secondary symptoms have lasted for a time, such as sore throat, skin eruption, &c., the following mixture may be employed instead of the pills:—

Bichloride of mercury,	2 grains.
Chlorate of potash,	60 ,,
Water,	to 8 ounces.

Of the mixture a dessert-spoonful in water is taken thrice daily after meals.

If the above treatment by pills is adopted as a precaution only, it should not be stopped after several weeks because no symptoms have appeared. It should be continued for at least six months, and preferably twelve months, though not necessarily continuously. It may be stopped for a few days at a time and then resumed, and if after four or six months no symptoms have appeared, the dose may be reduced to two pills daily. Where the secondary symptoms have appeared the treatment *must not be dropped* simply because the rash on the skin has disappeared, the throat become well, and the health has apparently been restored. It ought to be persisted in for twelve months, and beyond that if symptoms still exist. If symptoms have ceased long before the twelve months have passed, the medicine may be stopped for short intervals and then resumed, and smaller or less frequent doses employed. Six months must pass during which the person is free of symptoms before the person can be pronounced cured.

In the third stage of the disease the drug used is iodide of potassium in 3-grain doses, dissolved in water and taken twice daily. It is well, in ordinary cases, after ceasing the use of mercury, to use the iodide for several weeks. Iodide of potassium has a marked effect in the nervous troubles of the third stage. Thus for the continuous intense headache a dose of 10 grains may be given to begin with three times a day. The dose is daily increased by 3 or 4 grains till the person may be taking even 90 grains a day, or till the headache ceases, when the dose is gradually brought down; but the smaller dose is to be persisted in for months. Sarsaparilla in dessert-spoonful doses may be given with the iodide.

The modern treatment of the disease consists in the injection into a vein of an arsenical preparation called **Salvarsan**, made public by Professor Ehrlich of Berlin in 1910. It was also designated by him "606".

Great benefit is derived from treatment at sulphur baths, such as Aix-la-Chapelle.

Ulcers and other sores may be bathed with a wash containing, to each ounce of water, 2 grains of sulphate of zinc.

For children a flannel bandage should be made to fit round the belly. On the surface next the skin a piece of mild blue ointment of the size of a pea should be smeared nightly. The movement of the flannel rubs it into the skin, which should be washed every third day. By the mouth syrup iodide of iron, a third of a tea-spoonful, should be given thrice daily. Cleanliness and good milk are essential.

The extremely contagious nature of the disease has been pointed out. It is, therefore, scarcely necessary to say that a syphilitic person should abstain from sexual intercourse, from all contact, indeed, with others. It is probable, however, that in the third stage the contagiousness is not marked.

As regards marriage, it is almost a crime for a syphilitic person to marry before a year has elapsed without any sign of the disease. A person who has passed through the disease, and has been properly treated, should, therefore, not marry till three years have passed from the time of infection.

CEREBRO-SPINAL FEVER.

Cerebro-spinal Fever (*The Black Sickness* (popular name in Dublin)—*Spotted Fever*).—This fever is due to an organism, the **meningococcus**, and may occur in an epidemic form. It is rare after forty years of age, and is not uncommon among young children. The symptoms are due to inflammation of the membranes of the brain (p. 136) and spinal marrow.

Symptoms.—The disease may begin with feverishness, headache, pains in the back and limbs, and feelings of illness lasting for a few hours or a couple of days before any serious disease is feared. Usually, however, the attack is sudden, coming on with collapse and insensibility or with severe shiverings (rigors), intense headache and dizziness, excessive pain in the back of the neck and along the spine, constant vomiting, pain in the stomach and cramping of the muscles of the legs. The fever is not necessarily great, but the patient is restless and delirious or drowsy. The skin is over-sensitive, so that slight touches give rise to complaints of pain. One marked symptom is a stiffening of the muscles of the head and back, so that the patient's head and neck are arched back. A rash of blebs (*herpes*) appears on the lips. Purple spots (*petechiæ*) come out about the second day, in severe cases within the first twenty-four hours. They appear first on the legs. Purple blotches also appear over the body in very severe cases. Death may occur from collapse within a few hours of the attack, or from the first to the seventh day, the patient passing into stupor and from it to death. Death may not occur for several weeks, and may then be due to complications. Paralysis is a common complication, and so also are affections of eyes, ears, and joints.

Even in favourable cases the illness lasts from two to six weeks, the extreme weakness that results being a cause of the delay.

Treatment.—If the attack begins with collapse, it must at first be met with the application of heat to the limbs and over the heart, and the administration of small quantities of stimulants. Mustard plasters over the chest and back are also recommended. When this stage is over, the intense pains in the head and back are relieved by ice bags on the back of the head and along the spine. For the same purpose opium, given every two or three hours in 10 drop doses, as long as it appears safe, is recommended. *This must only be given to adults. Opium must never be given to children without express medical orders.* To them bromide of potassium in 5-grain doses every two hours may be advised.

Small quantities of strong beef-tea, and similar fluid nourishment, are to be given frequently.

At a later stage of the disease 3-grain doses of iodide of potassium may be given every four hours, to aid in the removal of the inflammatory material poured out on the brain. To children the dose should begin at 1 grain.

The disease is extremely fatal, often within the first twenty-four hours, owing to the nervous disturbance. The most hopeful treatment is by a serum injected into the spinal canal by what is called **lumbar puncture**, or by a vaccine or by both.

NON-INFECTIOUS FEVERS.

MALARIAL FEVERS.

(See Plate XXX.)

Ague (*Intermittent Fever—Marsh Fever—Malaria*).—Ague or intermittent fever is not a disease that may be communicated from one person to another. It is nevertheless a fever which is due to the introduction of some poisonous agent into the blood. That the poisonous agent is a living organism was first shown by an Italian observer, Laveran, but the credit of proving that the organism was introduced into the blood of the human being by the bite of an infected mosquito, of the genus Anopheles, belongs to an officer of the Indian Medical Service, Major Ronald Ross. Major Ross has shown that this kind of mosquito breeds in shallow puddles of water, not large enough to contain minnows or water-beetles, and not so small as to dry up quickly, in hollows of rocks left full of water by drying water-courses after rains, in badly-made drains and gutters and small pools containing green mould or water-weed, in disused wells, garden cisterns, water-butts, and so on. He has shown that in proportion as such things are drained or cleared out or filled up in malaria-infected settlements, the number of mosquitoes diminishes and the amount of malaria with them. Mosquitoes may also be destroyed in their breeding-places by pouring on petroleum oil, paraffin, or kerosene, or creasote, in sufficient quantity to make a thin film on the surface; and it appears that systematically dealing with such breeding-places in the roadways, back-yards, and immediate neighbourhood of houses of malaria-infected settlements and towns would in time clear them of mosquitoes and of infection.

Individuals will not suffer from malaria if they protect themselves from mosquito bites. This they may do by the use of appropriate gauze veils, by keeping the insects out of the houses by wire screens, by sleeping within mosquito curtains, and by similar means.

One attack of ague, instead of protecting against a second, renders a person more liable to renewed attacks from the least exposure to the poison. Moreover, one who has suffered from ague is liable to other attacks even without being again exposed to the action of malaria.

Fever may appear in persons within a day or two after the reception of the poison, while others may have been removed for months from the malarious district before evidence of their having become affected by the poison presents itself.

Symptoms.—The feature that marks marsh fevers is that there are several attacks of fever separated from one another by intervals, during which the sufferer appears comparatively well. In its progress the fever has three well-marked stages: the cold stage, the hot stage, and the sweating stage, following which is the period

PLATE XXX

MICROSCOPICAL APPEARANCES OF BLOOD IN MALARIA AND SLEEPING SICKNESS

The blood film in both these cases is obtained by the method described on p. 18.

The plate should be compared with Plate III showing healthy blood.

Both films show exact drawings, in colour, size, &c., of what is seen under a system of lenses magnifying by 1000 diameters, but the blood from the case of sleeping sickness is the blood of a rat, inoculated with the disease, and the blood cells are slightly smaller than human.

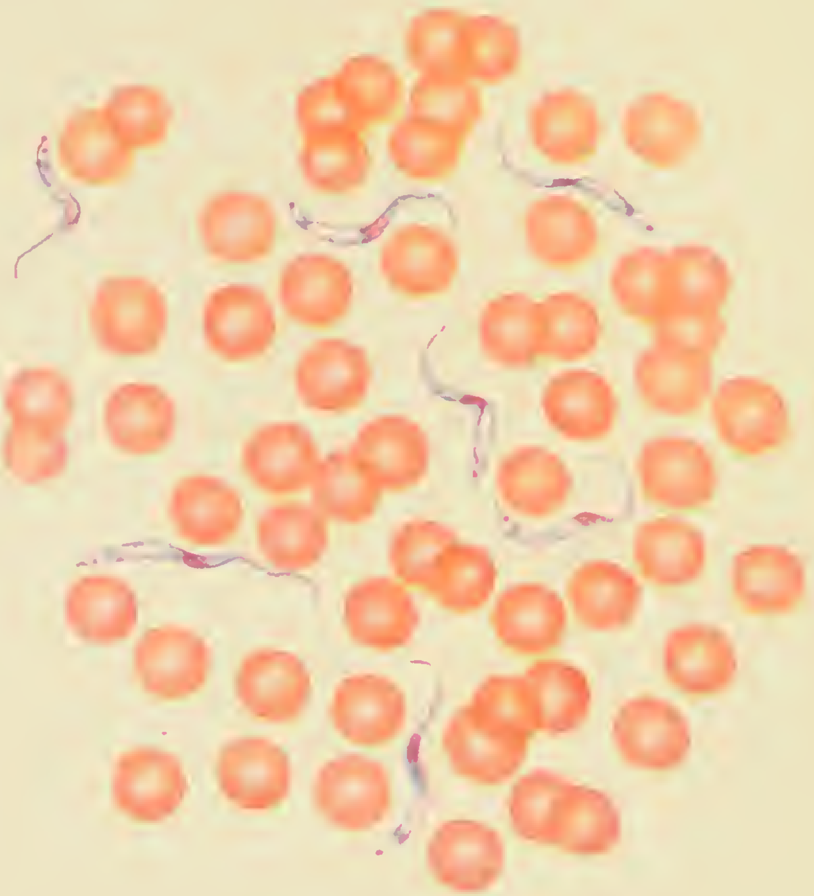
The malarial blood is from a case of tertian fever (see p. 549), and the stain used is different from that employed in the case of Plates III, IV, and V. The stain here used is Leishman's modification of Romanowsky's.

The film from the case of sleeping sickness shows parasites freely moving about in the blood; they are called **trypanosomes** (see p. 550). Notice the large round body about the centre and the small one near one end which pick up the colouring matter of the stain. It is from the small stained body at the one end that the flagellum or lashing filament has origin.

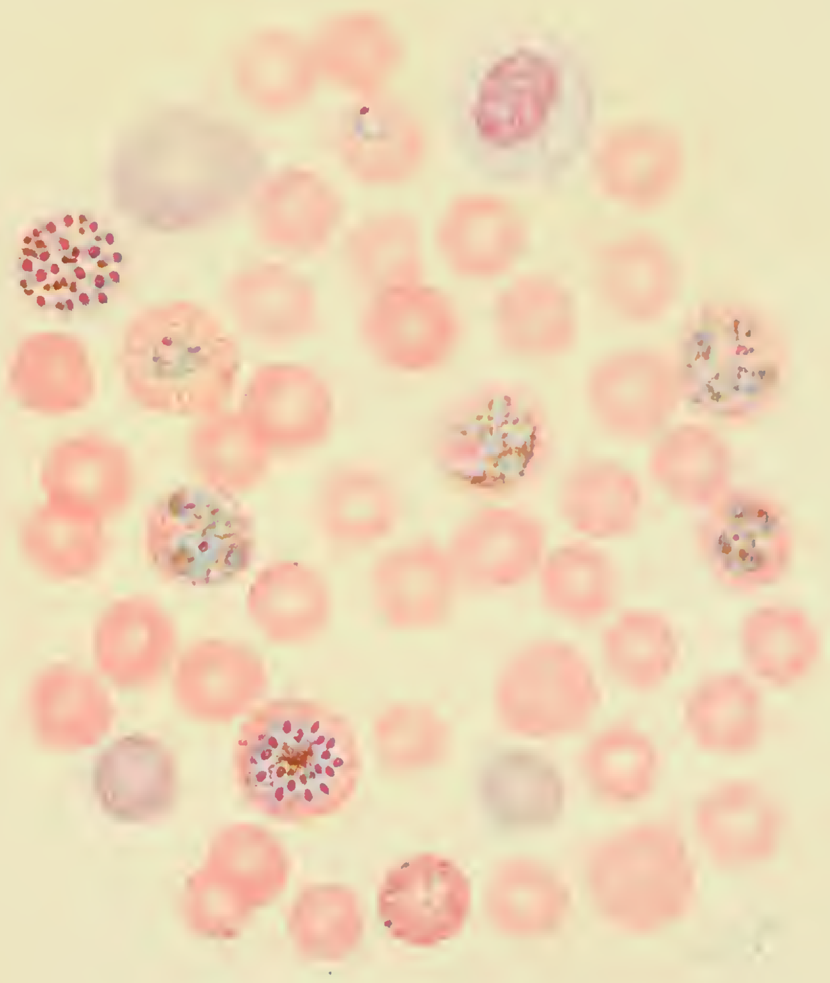
The other film shows the parasite of malarial fever in various stages of its development. It is noticed here that the parasite is not free in the blood, but develops in the interior of the red cells. A few normal red cells are seen about the top of the film. Just one cell from the top of the film is a red cell showing the parasite in a very early stage, a stage resembling a signet-ring. Three cells lower down to the left is seen another cell with ring-shaped parasite, but this is a later stage, for pigment is being deposited in the body of the parasite and generally through the red cell, giving it a spotted appearance. Straight below that is seen a red cell with two parasites growing in it, and in the centre and opposite side of the film the parasite is seen more mature and occupying a larger portion of the red cell. The final form taken by the parasite is seen in the upper left-hand corner and near the bottom of the film, where one cell in each place shows the division of the parasite into 20 or so spores.

It will be noted also that the infected cells are swollen, and that there are other red cells showing changes of degeneration (see Plate III), though containing no parasite. A large white cell with large faintly pink nucleus is seen in the upper right-hand corner.

MICROSCOPICAL APPEARANCES OF BLOOD IN CASES OF MALARIA AND SLEEPING SICKNESS



Film of Blood from a Rat infected with the organism of [illegible] Sickness—Trypanosoma nagana, stained and magnified 1000 diameters



Film of Blood from a case of Malaria, stained with Leishman's stain and magnified 1000 diameters

of the intermission, as it is called, in which the fever is completely absent. This period lasts for a variable time, and is succeeded by a second attack of the fever, going through the same stages as the first, ending in an intermission, followed by another attack, and so on. In one case the interval between the beginning of the first attack and the beginning of the second is only twenty-four hours. There is, in this case, a renewed attack of fever daily. This form is called **quotidian ague.** In another form, from the commencement of the first attack to that of the second is forty-eight hours. That is to say, there is a renewal of the fever every other day. This is called **tertian ague.** In a third form, the fever is renewed the third day from the beginning of the previous attack. This is **quartan ague.** In other cases the fever returns every fourth, fifth, or sixth day.

For some time before the disease actually attacks, the person may complain of weariedness, loss of appetite, headache, and pain in the back, or the disease may begin suddenly.

The **cold stage** is marked by a feeling of coldness; the person shivers; his teeth chatter and his limbs tremble violently; the face and hands are blue with the cold; and the skin is shrivelled and presents the appearance of "goose-skin". There is uneasiness about the stomach; headache and pains in back and limbs are present. Much very clear water is passed, and frequently. This stage may last from half an hour to several hours. The cold is only apparent, for if the temperature be taken with the thermometer (p. 38) it will be found already above the usual height.

The **hot stage** comes on gradually with the disappearance of the pinched and blue appearance of the skin. From feeling comfortably warm the patient becomes intensely hot, the face being flushed, skin dry and harsh, pulse full and frequent, and thirst being great. The person becomes restless, and sometimes slightly delirious. The headache is severe; and the sickness continues. This stage lasts from one to four or five hours, or even longer.

The **sweating stage** begins with the appearance of beads of perspiration on the face and brow. The hands and skin begin to get moist, and the person feels more comfortable. Soon copious sweating breaks out all over the body. The fever falls and the pulse becomes slower and softer. The breathing is less hurried than in the hot stage. Soon the fever is quite gone, and the patient comparatively well, but tired and inclined to sleep. The average length of the whole attack is from five to six hours, but it may be prolonged for double that time. In some cases one or other of the stages may not be well marked.

After a varying time a second attack comes on, as already noted, which goes through a similar course.

There is no definite time when the whole illness will pass away. But a person who has suffered from ague is always liable to renewed attacks on the slight provocation of a cold, indigestion, &c.

Persons who continue to reside in a malarious district, and who suffer from periodical attacks, gradually pass into a chronic state of ill-health, marked by a peculiar sallowness of complexion. Serious changes occur in the blood, liver, and spleen, producing a condition of poverty of blood and a tendency to dropsy, jaundice, and various other affections.

Treatment.—The treatment of ague is naturally twofold: that of the attack and that of the intermission. During the attack little can be done except in the way of making the patient as comfortable as possible. From the nature of the disease it is needless to attempt to arrest its progress. During the cold stage, therefore, the use of a plentiful supply of warm coverings, hot drinks, hot-water bottles, &c., will be grateful to the patient; and so, on the other hand, will be light coverings, a cool atmosphere, and tepid sponging of the body during the hot stage. It is during the period of absence of fever between two attacks that medicine must be administered to ward off, if possible, a new attack. The medicine to be given is quinine. Ten grains should be dissolved in water, to which a drop or two of tincture of steel have been added to aid the solution, and this dose given at the end of the sweating stage. It is to be repeated in four or six hours. After each renewed attack the quinine is to be administered in this way, and after the fever has ceased to return, the use of a daily dose of quinine must still be persisted in for a week or more. Nourishing foods should be administered, and to aid in the restoration of strength 30 drops of Easton's syrup (syrup of quinine, iron, and strychnine) should be given in water thrice daily before food.

Whenever possible a person attacked by ague should be at once removed from the marshy district.

The prevention of ague is best accomplished by efficient draining and cultivation of the district where it occurs, by the clearing of jungle, and by similar means. The exercise of great care may enable one to evade the disease. The person should sleep in the upper part of the house, should avoid going out late in the afternoon and early in the morning; all water should be filtered or boiled before use; excessive fatigue should be avoided; and quinine should be regularly taken.

Remittent Fever (*Bilious Remittent—Jungle Fever*) is a form of ague, but more severe in its symptoms and of a much more fatal tendency. It is due to the same cause as ague, and presents similar symptoms.

Symptoms.—The disease has its cold, its hot, and its sweating stage like ague. The cold stage is, however, very short, and hardly recognizable. The fever of the hot stage is very high, and this period is prolonged, lasting from six to twelve hours. The vomiting which occurs is violent and distressing. The material vomited up is first colourless, then bilious and sometimes bloody. The sweating stage is not so marked as in ague. With it the fever diminishes and the other symptoms improve, and the *remission* occurs, which differs from the interval of ague in the important fact that the disease does not disappear for a time as in ague, but simply abates to renew its violence in a short time—from ten to twelve hours. The remission usually occurs in the morning, and the fever is at its height at midnight. Day after day the attacks recur, usually at first with increasing severity. The illness lasts from five to fourteen days, and a favourable termination may be expected when the remissions are distinct and last for several hours.

Treatment is similar to that of ague. It is said to be well to begin with a purgative as soon as the disease manifests itself, and to an ordinarily strong adult 3 to 5 grains of calomel, the same of compound extract of colocynth and of powder of scammony, with 5 grains of quinine are advised. One blue and one compound colocynth pill with 5 grains of quinine form about the same dose. No more medicine is to be given till the first remission, when 10-grain doses of quinine must be administered as advised for ague. If the person cannot retain the quinine on the stomach it should be carefully injected into the bowel (see ENEMA). To relieve the sickness, small pieces of ice should be given to suck, and warm clothes are applied over the stomach. When the fever remits, nourishing food is necessary, and if the exhaustion is great, stimulants in repeated very small quantities. The other directions given under Ague apply equally to Remittent Fever.

Malta or **Mediterranean Fever** (*Undulant Fever—Rock Fever—Neapolitan Fever*) is common in Malta and in countries bordering on the Mediterranean. It is due to an organism, the Micrococcus Melitensis, extremely common among herds of goats, so numerous in Malta, by the milk of which it may be communicated. The organism is also found in the urine of infected animals, which, saturating the soil, may spread the infection. It is not communicable from one person to another. It may be mistaken for typhoid or malaria. It is characterized by waves of fever, of an intermittent type. This irregular fever may continue coming and going for many months, and is accompanied by constipation, profound anæmia and weakness, profuse sweats, rheumatic and nerve pains, and enlargement of the spleen. Change of climate is the best remedial agent, no remedies being of much value. Monkeys are very susceptible to it, and may assist in spreading the infection.

SLEEPING SICKNESS.

Sleeping Sickness is a disease prevailing in certain districts of Africa, specially in the districts of the Niger and Congo, and in Uganda, where many thousands annually fall victims to it. Believed at first to attack the negro race exclusively, it has been shown also to occur in Europeans. Early in the illness the patient shows little beyond disinclination to work. Later, fever of an intermittent type occurs, with frequent pulse, and tremor of tongue and hands. At this stage the patient is dull, heavy, and stupid-looking, and sometimes drowsy. Headache and pains about the body are complained of, and the speech is mumbling and thick. Weakness, bloodlessness, and emaciation characterize a later stage, the drowsiness deepens, the patient can be roused only with difficulty, and death occurs in coma.

This disease is due to the introduction into the blood, by the bite of a fly, of an organism called a trypanosome. Hence the disease has been called trypanosomiasis. The organism has a worm-like shape with a lashing tail (flagellum) at one end (See Plate XXX.). There are several species of this organism, which are parasites in the blood. One species is the cause of a disease of horses called surra, and is carried by gadflies; another species, carried by the tsetse-fly, is the cause of the tsetse-fly disease of Africa.

No successful treatment has yet been discovered.

SECTION XXV.

SOME GENERAL DISEASES.

Tuberculosis and Scrofula.
Rheumatism and Gout:
Acute Rheumatic Fever;
Chronic Rheumatism;
Muscular and Nervous Rheumatism.
Cancer.

TUBERCULOSIS AND SCROFULA.

Tuberculosis is the term applied to a general disease, due to the formation of tubercles in various organs of the body. The nature of tubercles has been shortly explained on p. 255, and at greater length on p. 372, but to give a complete idea of the disease, the chief points of these explanations may be again mentioned. **A tubercle** is a little nodule, gray in colour, about the size of a millet seed, consisting of a collection of round cells. It is to be considered as a new growth, foreign to the part in which it is present. The little nodule tends to increase in size by the growth of others round it. By its growth it destroys the substance of the part in which it is placed, occasioning also inflammation in the surrounding parts. It has no great vitality, and undergoes changes which begin in the centre of the nodule, the result of which is to convert the firm gray mass into yellow cheesy material. The process may go on till the nodule becomes quite broken down into soft matter, and, if the matter can break out from the part, an ulcer is left. Instead of softening, the nodule may become hard by the deposit of lime salts in it, and become converted into a little solid mass in the substance of the tissue where it is lodged.

Now the effects produced by the formation of such tubercles depend on the organ or tissue of the body in which the diseased process is going on. In the general disease tuberculosis the formation of the gray nodules proceeds in most of the organs of the body—lungs, liver, kidneys, lymphatic glands, bowels, membranes of the brain, &c., and the symptoms produced are those of a fever, and strongly resemble symptoms of typhoid fever. This form of the disease may last two or three weeks, and its termination is death. The true nature of the disease it is extremely difficult to recognize during life.

On the other hand, the formation of tubercles may be limited to one organ of the body, at least at first. Thus if the formation is principally in the lungs, it produces consumption (p. 372). In the bowels it produces consumption of the bowels (p. 255). The same process going on in the membranes of the brain is the cause of acute water-in-the-head (p. 155); and a similar tubercular deposit in lymphatic glands is believed to be the cause of the swelling and breaking down of the glands that are the main features of scrofula.

Recent investigations have tended to establish a relationship between the growth of tubercle and the activity of some peculiar form of germ. That tubercle spreads by contagion is evident. In cases of tuberculous consumption the throat is commonly affected by tubercular ulceration, so that the voice is hoarse and may be lost; and this is due to the contact of the spit from the lungs. Moreover, in such cases tubercular ulcers are usually found in the bowels, probably because the contagious matter is swallowed and the ulceration thereby extended. But definite experiments have conclusively proved the truth of the contagious character of the disease (refer to p. 501).

Tubercle is then due to an infection, but there may be a hereditary susceptibility to its attack; while no age is free, it is most common in early life.

It is needless to discuss the symptoms or treatment of the general disease, and the special affection of lungs, bowels, and brain have been considered elsewhere. Where the tendency to this form of disease is known to exist in families, much may be done to avoid its appearance. The general treatment is the same as that suggested for scrofula, which, as has been already indicated, is a manifestation of the tubercular taint.

Scrofula (*Struma—King's Evil*) is a constitutional condition in which the general health is much weakened, and in which there is a great tendency to slow inflammation of various parts of the body and to the formation of abscesses and ulcers slow to heal. (The disease was called King's Evil from the idea that it could be cured by the king's touch.) The organs of the body specially apt to suffer are the lymphatic glands, which become enlarged, softened, and readily break down, becoming converted into cheesy material. When it is the glands about the neck (p. 285) that are specially affected the disease is evident, but other glands, deep-seated and not within reach of examination, are equally prone to the affection, which may, therefore, not be so evident. Scrofulous persons are often in early life of a pasty complexion, pale and flabby, with sluggish circulation, stunted in growth, with short narrow chest, and prominent belly, and soft muscles. Others again are of bright fair complexion, with light red hair, and are unusually bright and clever. Many children, though apparently scrofulous, gradually grow out of this condition and become vigorous men and women.

While inflammation and formation of matter in the glands are the popularly known signs of the scrofulous condition, many other organs of the body may be the seat of scrofulous disease. Thus some kinds of inflammation of the eyes are essentially scrofulous; scrofulous diseases of bone and joints are common; chronic eruptions and ulcers of the skin, discharges from the ear and nose, are also frequently the result of the bad condition of health. Consumption of the lungs or bowels may arise from the same general weakness.

Scrofula is believed to be a manifestation of tubercle, discussed above, and the breaking down and suppuration of glands, the distinctive feature of scrofula, to be the result of the deposit within the glands of the tuberculous matter.

Treatment.—Nothing so much aids in the progress of a scrofulous tendency as bad food, bad air, want of cleanliness, and the absence of opportunities of healthy exercise, and nothing is so effective in removing the disposition to the disease as the removal of these evils. A scrofulous child should be regularly bathed; it should be clothed in flannel. Plenty of fresh air and sunlight are absolutely necessary. Nothing is, consequently, so valuable as a change from a close town to the sea-coast. Moderate sea-bathing is very useful. If this is not easily available, the child should be bathed at home daily in a bath containing sea-salt, and should be vigorously rubbed afterwards. Food is to be liberally allowed, especially sweet milk, eggs, soups, &c. Cod-liver oil is the chief medicine, and should be given for a long period, indeed long after health appears quite re-established. Most children learn to like it. Small doses should be given at first, half a tea-spoonful twice daily, and the dose should be gradually increased till a dessert-spoonful or a table-spoonful is being taken thrice daily. To those who, after patient trial, cannot get over the taste of the oil, malt extract or malt extract and cod-liver oil may be given. Another valuable medicine is iron, given as dialysed iron (4 to 10 drops—according to age—five times daily in water), or as syrup iodide of iron (a half to one tea-spoonful thrice daily), or as Parrish's syrup of the phosphates, commonly called chemical food, given in a half to one or two tea-spoonfuls thrice a day. The cod-liver oil and the iron tonic may be given at the same time.

Glands that have become swollen and painful ought not to be rubbed, nor irritated in any way (see p. 284). The oil and the syrup of iodide of iron ought to be persevered with, and the neck simply protected by a strip of flannel. Frequently the affected glands will recover under this treatment if not worried into suppuration. If, however, matter forms in the glands, the sooner a surgeon opens them the better.

RHEUMATISM AND GOUT.

Rheumatism and Gout are allied conditions affecting the body as a whole, and all the tissues of the body, though their worst and more marked effects may be shown at particular parts, in the joints, for instance, in rheumatism, and in the heart and in the great toe in gout.

In the introduction some idea has been given of the changes which take place in muscle, by which highly complex chemical changes occur in the muscle, some substances in or of the muscle breaking down in the process by which the work of the muscle is done. Waste substances are thus produced which require to be removed from the body. At the same time another process keeps pace with the breaking down, by which fresh complex substances are built up to replace those broken down. The breaking-down process is of the type called by chemists oxidation-processes, processes of combustion or union with oxygen. Now similar processes occur in all the tissues of the body, each tissue, muscular, nervous, and so on, having its own special kind of building-up and breaking-down processes, characteristic of the healthy activity of the tissue.

Now in rheumatism and in gout, for some reason not yet properly understood, these processes do not go on in a healthy way. It may be that the defect is due to some inherited tendency of the tissue, or it may be due to unhealthy conditions of living perverting the normal processes of the body, to improper diet or excesses of one kind or another. One result at least of the perverted action of the tissues is the production of unusual waste substances, or exceptional quantities of waste substances usually present in very small amount, which the organs whose business it is to remove the waste products find it difficult to deal with, and in attempting todeal with which they may ultimately suffer. The continued presence in excess of these waste substances in the tissues and in the blood act as irritants to them, and thus sooner or later diseased conditions arise. In one person it may be one tissue or organ that first begins to suffer, in another person another tissue or organ, dependent to some extent upon temperament or idiosyncrasy, in some cases doubtless dependent on occupation, for if, by the nature of his daily work, in one person one tissue or organ is subject to special strain, it is likely to be that tissue or organ that will first feel the effects of the disordered general tissue change.

This explains how it is that rheumatism and gout may manifest themselves in so many different ways in different individuals, or even in the same person, the kidneys being at one time disturbed, the joints at another, the skin at another, and so on.

The typical mode in which rheumatism attacks is in the form of an affection of the joints, attended by high fever and severe joint pain, called acute articular rheumatism or rheumatic fever, and this we shall therefore consider first.

Rheumatic Fever (*Acute Rheumatism, Acute Articular Rheumatism*).—Acute rheumatism is a disease accompanied by very high fever, and attended by characteristic joint pains. The tendency to the disease runs markedly in families; and previous attacks increase the liability of a return. It affects mostly persons under the age of thirty. Exposure to colds, chills after overheating, &c., are frequent causes.

Symptoms.—The disease usually appears with signs of an ordinary attack of cold, such as a general feeling of illness, loss of appetite, sore throat, disturbed sleep, pains in the bones, feverishness, &c., the signs of what is commonly called an influenza cold, symptoms described under catarrh (p. 214). The chief signs of the fully formed disease are high fever, pains in the joints, and severe sweats. The joints attacked are usually the larger ones, ankles, knees, wrists, shoulders, and elbows. The joints are not attacked all at once, but one after another as a rule, one joint getting well when another is becoming more painful. The pain is often excessive, so that the person lies straight and motionless in bed, afraid even of the slightest shake to the bed. The affected joints are hot, tinged with redness, tender to touch, and swollen. When the swelling has fallen, and the pain nearly gone, a feeling of stiffness remains. The muscles are also affected, and liable to painful twitchings. After the pain has begun in a joint, it increases till it is very severe, and then gradually dies away, the swelling disappearing with it. However much the joint may be swollen, matter is practically never formed in it. During the illness the whole body is bathed in sweat, which has a peculiar sour smell, easily perceived by everyone who comes near the patient. The sweats continue throughout the disease, and gradually pass off with recovery. The fever is often so high as itself to threaten life. In addition to these symptoms the tongue is white, appetite bad, bowels irregular, and pulse fast (120 per minute).

While these are the usual signs of a regular attack, the disease may occur in a much milder form, with slight fever lasting only a day or two, only one or two joints being affected. In many such cases the disease frequently returns.

The length of the illness is never very definite, varying from two to six weeks or longer, but when the patient is properly attended to the severe symptoms should not last much beyond nine days. Recovery of strength is, however, slow. Death from the rheumatism itself is not common. But in the train of rheumatism are a great many other diseases, especially heart disease—namely, valve disease of the heart (p. 319), and inflammation of the pericardium (p. 318),—inflammation of the lungs and air tubes, and various others. Indeed the great risk is that of affection of the heart.

Treatment.—The patient should be in an open bed, lying between blankets. The affected joints should be kept at rest. An aid to this is obtained by wrapping them in cotton-wool, secured by a flannel bandage. The principal medicine now given is salicine or salicylate of soda. It is administered in 20-grain doses in water every two hours for twelve hours or so, when the pains are generally relieved and the fever falls. Thereafter the powders are repeated every three or four hours or at longer intervals. The evil of the remedy is that it frequently produces deafness and unpleasant noises in the ears, and sometimes sickness and faintness. In spite of the noises in the ears, &c., the powders should be persisted in if necessary, as the unpleasant symptoms attending their use will pass away in a few days. But if sickness or faintness arise, a more sparing use of them must be made. It is marvellous how quickly in many cases this treatment relieves. When it does so, the dose should be continued twice or thrice daily for several days after the fever has passed away. Then a quinine-and-iron tonic should be given, and great care must be taken for some time to prevent a relapse. Sometimes this treatment fails. In such a case the old treatment with potash must be resorted to. Thirty grains of acetate of potash are to be given every 3 or 4 hours. At bed-time 10 grains (*to an adult*) of Dover's powder will relieve pain and help sleep. Quinine-and-iron tonics are also necessary after the fever has passed. Throughout the illness nourishing, easily-digested foods are to be given *in small quantities* frequently repeated. Milk and milk puddings, thin mutton broth, &c., are best, but no butcher meat should be allowed till recovery has taken place. Soda-water and milk is a grateful drink to the patient. The bowels also require attention, an ordinary purgative medicine being given as required.

Though the treatment has thus been mentioned in some detail, it is needful to say that no case ought to be without medical supervision, unless that is absolutely unavoidable. A physician will often detect commencing affection of the heart, and take steps to prevent it if possible. Neglected cases too often end fatally in time, because this evil has not been guarded against.

Chronic Rheumatism, as it affects the joints, is discussed on p. 74.

Irregular Forms of Rheumatism.—The muscles frequently suffer from the rheumatic taint, the chief symptom being pain, specially at night, and of an aching or stabbing character.

Rheumatic nerve affections are also frequent. They are usually of a neuralgic character. Thus sciatica may be of rheumatic origin, so also may headache. Inflammation of the tonsils and throat, inflammations of the eyelids and eye, and inflammations of the skin have also frequently their cause in rheumatic conditions of the tissues. The kinds of skin affection that are frequently rheumatic are such as nettle rash and the superficial inflammatory blush.

It is difficult to decide when the rheumatic poison is at the root of these disturbances. But there is never any harm done by trying anti-rheumatic medicine in small frequently-repeated doses, such as salicylate of soda (5 grains), or iodide of potassium (3 grains), or salol (5 grains), repeated four or five times daily for a time. In the muscular and nerve affections, massage, rubbing, warm salt-baths, hot and cold douching will be found useful.

Gout is a markedly hereditary disease, descending from parents to children in a very remarkable way. Men are more frequently attacked than women; the age most liable to the disease is between thirty and forty-five. The circumstances that usually determine an attack in those liable by inheritance to the disease, or that excite the disease for the first time, are habitual excess in eating, specially in the over-eating of animal food and rich dishes, long-continued excess in drinking, especially strong wines, such as port, sherry, madeira, and malt liquors (beer and porter), and prolonged want of proper exercise. It appears also that persons subject in their occupation to the influence of lead are rendered more liable to an attack, if other circumstances favour it. It appears that the disease is due to an excess in the blood of a substance called uric acid, either because it is formed in the body in too large quantity, or because it is not removed from the blood by the kidneys in the urine as it ought to be. It is a disease specially apt to return frequently, very slight causes being sufficient to determine an attack in those subject to it. Thus even a slight degree of indigestion, irregularity of bowels, cold, mental anxiety or worry or excitement may occasion a fit of the gout in gouty persons.

Symptoms.—An acute attack of gout usually comes on suddenly during the night with pain and swelling in a joint, commonly the joint that forms the ball of the great toe. The joint becomes not only much swollen, but also turns red and shiny, the veins on the foot and part of the leg being very marked. The pain is often extremely severe, and is burning or shooting in character. Other joints may also be attacked, the smaller ones specially. The least movement is almost unbearable, and even the weight of the bed-clothes is not endurable. Towards morning the pain lessens, but next evening it returns, and this may continue for a week or ten days, when the severe symptoms pass away, though the joint remains swollen and tender for some time longer. However swollen the joint may be, matter does not form. Attending the joint affection there are general symptoms of disturbed health, shiverings and sweatings, loss of appetite, white tongue, increased heat of skin, quick pulse, confined bowels, and scanty high-coloured urine from which a brick-red deposit separates out on cooling. The sleep is much disturbed; cramps and startings of the muscles of the leg are common; and the patient is of very irritable temper. After the first attack the joint apparently quite recovers. As a rule the disease returns sooner or later, generally within a year; and not only does it tend to return, but the intervals between each "fit" become shorter. With the greater frequency of attack, more joints are liable to suffer—joints of foot, hand, ankle, knee, &c. As the disease becomes chronic the joints become permanently altered. They enlarge, and deformities are produced, due largely to the deposit within the tissues of the joint of masses of urate of soda, called "chalk-stones," which not only form prominences and irregularities, but by being deposited around the joint tend to fix it in unusual and awkward positions. Abscesses may form round the chalk-stones, from which they may be discharged, leaving ulcers. The general system tends to become affected and the person to grow feeble and weak.

Those who suffer from attacks of gout are often warned of an on-coming "fit" by symptoms not well marked, but which, by experience, they know too well the meaning of. Those symptoms may be connected with the digestive organs—flatulence, heartburn, irregularity of bowels,—or connected with the heart, such as palpitation; or there may be headache, irritable temper, and various other nervous symptoms.

There are forms of irregular gout that show themselves by severe stomach disturbance, such as acute spasmodic pain or cramp and bilious vomiting, or by disturbance of the heart, evidenced by palpitation, faintness, &c. By similar attacks of irregular gout the breathing may be much disturbed, and rendered so laborious that suffocation seems to threaten. Nervous and other symptoms may also be due to a similar cause.

Treatment.—Very strict regulation of the habits of life is one of the most important elements in the treatment of gout. The person must exercise great restraint in eating, and must take no more than is necessary for proper nourishment. A mixed animal and vegetable diet is the best, but the amount of animal food in particular must not be in excess. Of this class of food the best kinds are white fish, game, fowl, and mutton. Fat meat such as pork, salted and spiced meats, and all rich dishes are to be avoided. In regard to vegetables, some believe in the free use of celery. Stewed fruits are allowed, but no pastries, and the fruits should be sparingly sweetened. Extreme moderation in drink is absolutely necessary, beer, porter, and rich wines, champagne included, being rigidly abstained from. Such wines as hock, moselle, claret, alone are safe; whether they should be used at all, and, still more, whether any whisky or brandy may be taken, ought to be left to the decision of a medical attendant. Water should be the principal drink. Tea and coffee are not necessarily harmful. Potash, soda, and lithia water may do much good, and ought to be taken freely, but only between meals.

The gouty person should take regular outdoor exercise daily, and should go early to bed and rise early. The clothing should be warm. Baths are of great use, and specially a well-ordered Turkish bath. Exposure is to be avoided; and sudden changes of temperature are to be guarded against. For this reason, where a choice can be made, an equable climate is to be preferred. As regards treatment during an acute attack, it should be begun with opening medicine, such as rhubarb (10 grains) and bicarbonate of soda (15 grains), the dose being repeated as found necessary. To relieve the pain the drug most extensively used is meadow-saffron or colchicum. The preparation used is the wine, given in water in 10- to 30-drop doses every four or six hours along with 6-grain doses of citrate or carbonate of lithia or potash. The use of the colchicum may be continued for several days if it agrees with the patient. At the same time the action of the skin and kidneys is to be promoted by the patient being kept warm, and drinking freely of barley-water, soda-water, or cream-of-tartar water flavoured with lemons. The food should be light and nourishing—milk and bread, a little beef-tea, &c.—and rather spare in quantity. The affected joint should be kept at rest, supported in a raised position, and surrounded by a piece of flannel dipped in warm water, and covered by cotton-wool.

In chronic cases 3 to 6 grains of carbonate of lithia should be taken twice daily in a wine-glassful of water, and Carlsbad or Vichy water largely used.

CANCER.

Cancer (Latin, *cancer*, a crab—*Carcinoma*).—The name of this disease is derived from the appearance of the part attacked by the disease, as it struck the ancients, the veins surrounding the diseased part resembling a crab's claw.

Cancer is considered in this section more as a matter of convenience. It is still a question much discussed whether cancer ought to be counted a local or a constitutional disease, and many reasons can be adduced for answering the question either way. It is certain, however, that after cancer has appeared in any part, however small and limited its position may be, and however insignificant it may appear, it will in time spread along various channels and affect the whole system.

Nature.—Its character is that of a tumour, swelling, growth, or deposit which tends to spread, not simply by becoming larger and squeezing aside the healthy substance of the part in which it is placed to make room for itself, but by growing into the healthy parts, invading them, and incorporating them into itself. It can never, therefore, be removed from its position as a whole without other parts being disturbed, but if removed the whole mass of tissue in which it is placed must be cut out with it. Moreover, even if removed, it tends sooner or later to return, perhaps just because it so invades the tissues that it is impossible to make sure that all of it has been removed. This feature of it is one of the chief reasons why it is called "malignant." For it is evident that a tumour whose tendency is always to return to the attack is likely some day to overcome its victim. A "simple" tumour, however, is one which, once removed, is done with. Not only does cancer tend to spread by direct invasion of the substance of the part where it is placed, but it also tends to spread to distant parts by conveyance along vessels. Blood-vessels are doubtless channels along which particles of cancerous material may be carried to parts at some distance from the original growth, and which, taking root in the new situation, proceed to grow and form a secondary tumour. Other channels which afford an even readier means of transit are the lymphatic vessels, which, as has been noted on p. 278, are found in every tissue of the body as drains for the removal of excessive nourishment supplied to the part, and also for the removal of waste products. Into these channels, therefore, juice and particles from the tumour will find their way. The lymphatic vessels pass to lymphatic glands in order that the material they carry may be worked up into a fit state for return to the blood. Thus it is that some time after a cancerous tumour has appeared in some part of the body the glands in the neighbourhood are almost certain to be found enlarged and otherwise affected. It is this that renders it so difficult to remove a cancerous growth with any certainty of permanent cure. For the cancerous material may have been carried considerable distances from the original tumour by such channels, without any signs of the transference being evident for a long time. It is this also that renders it imperative that a cancerous growth should be remorselessly cut out as soon as it is discovered, and the smaller and more insignificant the growth appears the more eager should the patient be for its removal. But it is just at this stage of its growth that patients are indisposed to permit an operation. It is so small, or it gives so little, perhaps no trouble, what is the need of operating at present? Wait till it is bigger, painful, troublesome, then the patient will consent. It is necessary earnestly to insist on the undoubted fact, the reasons for which have just been given, that it is while the growth is small and trifling that its removal is most hopeful, and that waiting till it is bigger means practically waiting till it is hopeless.

As to the nature of the growth itself, cancer is essentially formed of a degenerate kind of cell, and is originally connected with structures mainly of the epithelial type (see p. 55). Thus the surface layer of the skin consists of epithelial cells (p. 412), the mucous membrane of the mouth has a similar superficial layer (p. 195); the stomach and whole length of the intestinal canal (p. 198) has an outermost layer of cells; the membrane covering the windpipe and tubes of the lungs, as well as the air spaces of the lung themselves, are covered with epithelial cells (p. 343); the kidney and bladder have similar inner coatings (pp. 394, 398), while glands—the salivary glands (p. 196), the glands of the stomach and intestine (p. 199)—are also lined with epithelial cells. Now it is in these situations and others of a similar character that cancer is found, the cells coming under some degenerative influence, which causes them to multiply in enormous numbers and thus to invade the surrounding tissues and form deposits. The cells are held together by a small amount of connective tissue (p. 56), in whose spaces the cells lie. A cancer tumour is thus a growth formed of masses of cells in groups held together by connective tissue, the cells being originally derived from the natural cells of the part.

Varieties of cancer depend mainly upon the relative proportions of the cells and binding tissue, and of a fluid—the cancer juice—also present in the growth. Thus **hard cancer** or **scirrhus** has the binding tissue in greatest abundance, and forms a very hard tumour; **soft cancer, encephaloid** or **medullary cancer**, contains more cells and is of a very soft consistence, growing also with greater rapidity than the hard variety; while **epithelioma**, or skin cancer, consists mainly of flat cells like those of the skin, or cells similar to those of glands, and occurs in the shape of an irregular ulcer.

Seat.—The position of the tumour may vary as already indicated. It may occur on the skin or on mucous membranes, like that of the tongue, lips, stomach, and other parts of the alimentary canal, in the bladder and womb, in glands, such as the salivary glands and breast, the glands of the intestinal tract, the liver, the testicle, the lungs, the eye, bone, lymphatic glands, nose, and many other parts. In fact it may occur almost anywhere. For even though it may originate only in epithelial structures, as already noted, it is easily transmitted to other parts, in which it could not begin, by the channels of the blood-vessels and lymphatics. In men a common seat of cancer is the lip, where it is of the epithelioma variety. In women the breast and womb are frequent situations, hard cancer being most frequently in the breast. Internally the stomach, liver, and lungs are common situations.

The **causes** of cancer it is not easy definitely to state. Undoubtedly hereditary influence is great in many cases. Age has something to do with liability to the disease. The greater proportion of cases in men occur between fifty-five and sixty years of age, and in women between forty-five and fifty-five. It is twice as common in women as in men; and the liability seems to be greater in women who have borne children. These are of the nature of predisposing causes (see p. 28). Sometimes the occurrence of the growth seems to be determined in position by the presence of some long-continued irritation. Thus the irritation of a short juicy pipe, constantly smoked, has determined the appearance on the lip, and the irritation of a ragged tooth on the tongue, while cancer of the breast in a woman has followed at no distant time a blow on the breast. Frequently, of course, no such local cause can be suggested. It may be that with a constitutional tendency to the disease, it only required such an irritation to determine its occurrence.

The **progress** of the disease is slow or rapid according to the variety of the growth and its site, soft cancer being rapid in growth, epithelioma very slow. In its course the tumour continues growing for a certain time, and then it begins to break down, an irregular ulcer being formed from which a fœtid discharge proceeds. In time, sooner or later as the disease spreads quickly or slowly, and according to the speed with which it extends to other organs, the health suffers, and a constitutional state arises to which the term "cancerous cachexia" has been applied. The countenance is peculiarly pale and sallow, and the sufferer wears a very anxious and careworn look. The general surface of the body acquires a yellowish hue, the appetite is diminished, the strength gradually fails, and the pulse is weak. The patient complains of lassitude and of inability for exertion. Emaciation sets in, at last death ensues from exhaustion, or the combined effects of discharge, debility, and pain. Life may, however, be shortened more speedily owing to the interference of the tumour with the functions of some important organ, or to frequent attacks of bleeding from the ulcerating surface, caused by the disease opening into blood-vessels.

Symptoms of cancer it is impossible to discuss in detail. Those of cancer of the womb will be considered in the section on DISEASES OF WOMEN. As regards internal cancer, its presence requires for detection a skilful and experienced physician. Concerning cancer of the lip and tongue it is only necessary to say that the presence of a ragged ulcer, with hard base, from which a foul discharge proceeds, and which refuses to heal, is suspicious, and ought to cause the sufferer to seek early and skilled advice.

Treatment.—No drug will cure cancer. The virtues of one medicine after another have been lauded in vain. Time and more experience have shown the worthlessness of them all. The only treatment for cancer is removal, if that is possible. Caustics have been used to burn out the mass, and are occasionally used still, but removal by the knife is the preferable operation. This a surgeon will not undertake unless with a prospect of being able to remove the whole growth. It must, therefore, be done early, before the disease has invaded lymphatic glands and other organs. When it is too late to operate, the only treatment is one to relieve the symptoms, to support the strength of the patient, and to alleviate pain. Each case must, however, be treated on its merits, and requires medical supervision.

Cancer of the Breast.—The breast is one of the most frequent sites of cancer in women. The most common time of life is about the "change of life." Any of the three varieties named above may occur.

The variety called **Epithelioma** very often shows itself first as a hack, crack, or fissure about the nipple, which fails to heal, and from which a thin discharge leaks, forming a crust. The crack tends to form an ulcer. Now there is almost nothing about this hack or fissure to mark its malignant character, except its refusal to heal; but if a little bit of it be cut out and examined under the microscope its essentially cancerous nature will be revealed. In any case of doubt, therefore, this test should be applied. No woman should ever wait till the true nature of the fissure is shown by other symptoms, such as enlargement of glands in the armpit, for then the chances of success of an operation are diminished. If, before other symptoms appear, a microscopic test indicates a malignant growth, *removal of the whole breast should be immediately performed.*

Cancer may also begin in the breast as a lump or swelling within the substance of the breast. Hard cancer (scirrhus) and soft cancer (medullary cancer) both begin in this way. It is often purely accidentally that a woman discovers that such a swelling exists. She should not delay a moment in such circumstances to get capable advice. Sometimes it is the occurrence of sharp stabbing pain that causes a woman to feel the breast, and thus to discover that there is a lump in it.

Now in the case of scirrhus this lump is of **stony hardness.** If manipulated it is found to be of globular outline, and to be firmly connected with the rest of the breast. It cannot, that is to say, be moved apart from the structure of the breast. Its edge is not well-defined, but it thins off there into the substance of the breast. As it grows, its grip, so to speak, causes the nipple to be drawn in or retracted. This is a most significant sign, and fine offshoots, becoming connected with the deep layer of the skin, hinder the skin moving freely under the finger. As it grows, the disease spreads to the lymphatic glands of the breast, side of the chest, and armpit, which can be felt as hard nodules under the skin in these situations. Pain is frequent—sharp, stabbing pain,—though it may be entirely absent.

Soft cancer has similar characters, except that of stony hardness. A further sign, sometimes present, is a thin discharge from the nipple, mixed or tinged with blood.

In the course of its growth the tumour approaches the surface, and more and more tends to involve the skin, which becomes purplish in colour, and finally breaks down into a ragged ulcer from which an offensive discharge leaks. If the growth be not removed, it rapidly increases on the surface as well as in the substance of the breast, forming a raw, foul, fungating mass, and the patient dies of exhaustion or of the implication of some vital organ.

The growth ought never to be permitted to reach such a stage. At the earliest possible moment the whole breast and all the infected glands up in the armpit should be swept away in the most thorough manner.

But every tumour in the breast is not malignant, and there is quite a variety of growths, cysts, fatty and fibrous and glandular tumours, of an entirely innocent kind.

The important point, therefore, is to determine as early as possible whether a growth is innocent or malignant. Frequently the only way to do this is for a surgeon to cut down upon it to see it, or to remove a piece and to examine it microscopically. This is a course to which no woman should refuse her consent, because if she waits till the true character is apparent, her best chance of recovery has gone past.

SECTION XXVI.

THE MANAGEMENT OF CHILDREN IN HEALTH.

The High Mortality of Children and its Causes:

The Management of the Newly-born Child:
Food—Its nature—Frequency of supply—Choice of a wet-nurse—Rearing by hand—"The Milk Mixture."
Bathing and *Clothing;*
Exercise, Air, and *Sleep;*
Use of Medicines;
Premature Children;
Vaccination.

The Management of Children between the Sixth Month and Second Year:
Food—Weaning;
Teething—Milk-teeth and permanent teeth—Their periods of cutting;
Bathing, Clothing, and *Exercise;*
Children's Apartments.

Period and Rate of Growth in Children:
The Value of Periodical Measurements.

Standards of Growth:
Tables showing Height, Weight, &c., at different Ages—
(1) in boys and men of the artisan class,
(2) in girls,
(3) in boys and men of the most-favoured classes.
Comparison between Growth of Boys and Girls, and between Growth of Boys of different Classes.
The Relation of Height to Weight—Tables showing Increase in Weight corresponding to a certain Increase in Height.

HIGH MORTALITY OF CHILDREN.

That there is need for spreading broadcast fuller knowledge than the public evidently at present possesses of the proper methods of dealing with children, both in health and in illness, is strikingly evident from the statistics carefully collected and detailed by the late Dr. Wm. Farr, of the Registrar General's Office. The facts are so clearly given in Dr. Farr's own words in his annual reports that a few extracts will best show what they are.

"In England and Wales the deaths of 2,374,379 infants in the first year of age were registered in the 26 years 1838–63; and of the number 1,329,287 were boys, 1,045,092 were girls."

"Nearly 100,000 infants die annually in the proportion of about 56 boys to 44 girls."

"Even in the healthy districts of the country, out of 1,000,000 born, 175,410 children die in the first five years of life; but in Liverpool district, which serves to represent the most unfavourable sanitary conditions, out of the same number born, 460,370, *nearly half the number born*, die in the five years following their birth."

That is to say, one in every six children born dies within the first five years of life, even in the healthy parts of the country, but in the unhealthy parts the proportion is one-half. Moreover, Dr. Farr showed that the majority of the deaths occurred *within the first year of life.* Thus "of 100 children born, 15 die in the first year, 5 in the second, 3 in the third, 2 in the fourth, and 1 in the fifth; making 26 in the 5 years of age. Of the 15 who die in the first year, 5 die in the first month of life, 2 in the second, and 1 in the third."

Now what is the cause, or what are the causes, of such a tremendous infant mortality? That question also Dr. Farr tries to answer. The result is given in tabular form. In the three years 1873–75 the annual number of deaths, from all causes, of children under one year of age to every 1000 births was 278. The separate causes of these 278 are given in the table:—

Total number of deaths to every 1000 births,		278
Of which the number of deaths caused		
by premature birth and atrophy (wasting) was		70
,, lung diseases	,,	51
,, convulsions	,,	31
,, diarrhœa (looseness of bowels)	,,	24
,, tubercular disease	,,	21
,, whooping-cough	,,	12
,, teething	,,	6
,, measles	,,	4
,, scarlet fever	,,	3
		222

The causes of the remainder are not detailed.

Of the 278, no less than 125 were due to such diseases as atrophy (wasting), convulsions, and diarrhœa. Commenting on the table Dr. Farr says: "Some of the principal causes are improper and insufficient food, bad management, use of opiates, neglect, early marriages, and debility of mothers; but whatever may be the special agencies at work which are so prejudicial to infant life, it must be borne in mind that a high death-rate is in a great measure also due to bad sanitary arrangements." "*The causes of death which are more directly the result of neglect and mismanagement are convulsions, diarrhœa, and atrophy*;" and again, "the causes most fatal to infant life in factory towns, and which are inseparable from bad nursing and feeding, are diarrhœa, convulsions, and atrophy."

It is to be observed that in this table the number of victims of measles and scarlet fever is small, but it is in the second, third, and fourth years of life that these diseases are worst, and not during the first year, to which the table is limited.

It seems that since 1875 a considerable decrease has taken place in the average English death-rate, a decrease affecting not only the adult portion of the population, but the infant portion as well. It seems plain that this improved state of affairs is due to the operation of acts of parliament referring to public health, to the greater care consequently taken to keep down and rectify, as far as possible, unhealthy conditions, to more vigorous measures in dealing with and preventing the spread of infectious diseases, and to other similar causes.

Thus in 1903, in England and Wales, the births had increased to nearly 950,000, of whom a few short of 125,000 died, that is to say 132 out of every 1000 died before reaching their first birthday.

In 1904 the rate was for England and Wales 146 per 1000 births.

But in certain densely-populated parts of the country the rate was considerably higher. Thus in 1904, in Birmingham, 175 out of every 1000 died before the age of 1 year, and in Liverpool 180 per 1000 births.

In Scotland, for 1902, 144 boys of every 1000 born died before reaching their first year, and of girls 113 out of every 1000.

These figures show that public health acts touch very little those great causes of infant mortality noted by Farr, "neglect and mismanagement," which are still the chief causes of an unnecessarily high rate of infant death. These causes are not limited to particular classes of society, though they may be more strikingly evident in one class than in another. Mismanagement of children is certainly very common in every grade of society, and is as frequent a cause of childish ailments in the houses of the rich as in those of the poor. This section is, therefore, devoted to a consideration of the proper methods of managing children in health.

THE MANAGEMENT OF THE NEWLY-BORN CHILD.

BREAST-FEEDING.

From the day of its birth till it is four or six months of age the child should be nourished, in ordinary circumstances, *entirely* by its mother's milk, and during that period no other food of any kind whatever ought to be allowed. It is a mother's chief duty in relation to her child to suckle it, and neither her pleasure nor convenience should, for a moment, be allowed to come into consideration. A bad state of the mother's health may make it advisable, not for her own sake only but also for her child's, that the child should be otherwise reared, but this is the only valid reason as a rule.

It often happens that there is no milk in the mother's breasts for some hours after the birth of the child, and it is the custom of most nurses in the meantime to feed it with spoonfuls of sweetened water. This is entirely a wrong and unnecessary proceeding. There are few children that cannot afford to wait for twelve or even twenty-four hours. The proceeding is also hurtful, leading to irritation of the child's stomach, and the production of wind, colic, and other evils. In every case the child should be put to the mother's breast immediately after it has been washed and dressed, if the mother is not too tired, and at latest within an hour or two after birth. It often needs the exercise of some little patience before the child obtains a proper hold of the nipple. It should be aided by the nipple being drawn out with the fingers and moistened with milk. If there is milk in the breast the child will obtain satisfaction, and will soon relax its hold and drop off to sleep. The nipple should be removed from its mouth and dried to prevent hacking. But if no milk has been in the breasts, some advantage is yet gained in the drawing out of the nipple, and in the stimulus which has been given to the gland to hasten its activity. Between two and a half and three hours after the last suckling the child must again be put to the breast, and this is the proper interval between each period of suckling for the first ten days or a fortnight after the birth. Regularly as the clock comes round towards the third hour, *night and day*, for the period named, the child is to be lifted to its mother's breast. This is the first rule of infant nursing. It must not be broken for any reason. It is a great temptation, if the child is sound asleep, to let the hour slip past; and many are proud to tell how the child slept for five or six hours on end. This is a mistake. The child must be wakened at the hour and sufficiently roused and kept awake till it has taken a proper quantity of milk, when it will in all probability, drop off at once to sleep again. On the other hand, if it has been allowed to sleep for five or six hours, the chances are that wind has collected in its stomach and bowels, and its next drink will be followed by an attack of colic and a screaming fit. The mother or nurse will pay dearly for her five or six hours' rest by half an hour's entertainment of this sort. If, on the other hand, the rule is strictly followed, the child will fall in with the regular ways almost naturally. Within a couple of days the mother will have no need of a clock to regulate her suckling. The child will wake up at the hour with almost perfect regularity, will go to sleep after its drink almost immediately, and in ordinary circumstances will give no trouble whatever. Each breast should be given alternately. Often one nipple is hacked and very painful, and the mother shrinks from giving that breast, and delays. This is a most serious mistake, and the greater evil of a "gathered" breast may be the result. To prevent such results the slightest crack of the nipple should be treated thus: Carefully dry the nipple after each suckling and place over it a pad of cotton-wool, the centre of which is soaked with glycerine of tannin (obtained from druggists). Before the child is again put to the breast remove the wool and bathe off the glycerine of tannin, which is again applied when the child is removed. If this is not sufficient to heal the hack, then let the mother secure, without delay, a glass nipple shield with india-rubber tube and teat attached. (Pl. XXXI.—Appliances for the Nursery.) Usually the shields are sold with the teat on the end of the glass, no tube intervening. It is better to have the tube, because by it the mother may apply the shield and herself suck till the milk fills the tube, then putting the teat into the child's mouth. Thus the child is not worried by sucking in vain for some time. The shield should be worn at each suckling, and the wool with glycerine of tannin applied in the interval till the nipple is quite healed.

Usually mothers err by giving the child drink too often. If the child is the least peevish or fretful, the nipple is forced into its mouth to stop its crying, and the child, whether hungry or not, instinctively begins to drink. Should the fretfulness have been caused by the uneasy feelings of an overloaded stomach, this only increases the evil.

The mother must also take care that the child does not drink too much at one time. It usually indicates itself when it has had enough by withdrawing from the breast. It should, therefore, be allowed to drink till it voluntarily leaves off, and should not be urged to resume it again. If, as is frequently done, the nipple be again put into the infant's mouth, the mere contact calls into play the instinctive act of sucking, with the result that more milk than is needed is taken, the stomach is overloaded and may soon indicate this by rejecting some of its load, or, if it remain, the child is uneasy and restless for some time afterwards.

It sometimes happens that a proper flow of milk is not established for several days after the birth of the child. It may be no milk is forthcoming for a day or two. In these circumstances the child should still be put to the breast occasionally to excite the gland, but it must also be regularly fed. For this purpose a mixture of one-third cows' milk and two-thirds warm water, barely sweetened with loaf-sugar, or, better still, sugar of milk, is the best. It should be given, *not by spoon, but through an ordinary feeding-bottle*, to accustom the child to the use of the nipple. As the mother's milk is gradually formed, the supply of this mixture should be diminished, till, with an abundant supply of the former, the latter is entirely withdrawn.

The first breast milk is of a peculiar character. It is thicker and of a yellower colour than ordinary breast milk, and is called **colostrum**. It usually acts upon the child's bowels, and aids the expulsion of the material present when the child is born, which is usually of a dark offensive character. It is beneficial, therefore, to the child to get this first milk, and *it makes it unnecessary for the child to have any other opening medicine.*

A nursing mother will not take long to discover that the qualities of her milk vary with her state of health, and with the character of her diet. If she is honestly doing her duty towards her child, she will soon regulate her own food by the one condition of its agreeing with her infant. Her food must be abundant, for it must supply the wants of herself and her child. The intervals between each of her meals ought not to be too prolonged. Four hours or thereby is as long an interval as is advisable. If she has fasted long, and, before herself taking food, suckles her infant, the child is apt to be disturbed and uneasy. The food should be plain and nourishing, abundance of milk, bread and milk, porridge and milk, milk puddings, eggs, fish, soups, flesh and fowl, prepared in simple methods. Highly spiced dishes, with pastries and puddings, green vegetables, uncooked fruits, cheese, &c., are very likely to call forth very strong objections from the child. Every mother, however, must determine for herself what she can safely take, so far as her child is concerned, for what one mother dare not take without exciting screaming fits in her child, another mother can take without her infant being the least disturbed.

As a rule stimulants are not necessary or desirable. If, however, a mother has reason to believe that her milk is not sufficiently nourishing to the child, its quality may often be improved by her taking about one-third of a pint of good stout to dinner, and perhaps the same quantity towards evening.

The milk is profoundly affected by the mother's state of mind and body. If she has been over-fatigued, if she has been worried or annoyed, her child is likely to suffer, and to add to her troubles. But nothing so quickly and seriously affects the quality of the milk as sudden emotion, passion, or excitement of any kind, a sudden fear, or fright, &c. The bad effects exhibited in the child are sometimes extremely serious and prolonged. Therefore a mother should endeavour to maintain an equable and calm frame of mind. She should avoid all undue excitements, pleasurable or painful. She should always have her due amount of sleep, and a daily moderate amount of exercise.

The quality of the milk is affected by another circumstance. As a rule, so long as the mother continues nursing, her monthly illness does not return, and also as a rule she does not become again pregnant. But the rule has numerous exceptions. It is very seldom that the monthly illness of a nursing mother returns soon after delivery, but not so uncommon for it to return about the sixth or seventh month. During the period of the illness the milk is impaired in quality, and the child is likely to be fretful and its digestion to be disturbed. If this happens while the infant is still quite young it may necessitate the mother giving up nursing, but if the child is already six or seven months old it need not cause any inconvenience. The child is probably already having some artificial feeding, and during the period of the illness the breast may be withheld more than usual. It rarely happens that pregnancy occurs during nursing except towards the end of the nursing period. If it do occur, nursing must be given up.

To repeat: *Up to the age of four or six months the child is to be fed entirely by its mother's milk; it should be put to the breast at regular intervals of about three hours at first, nothing, neither the child's sleep nor the mother's, being allowed to interfere with this arrangement, which is carried out by night as well as by day; after ten days or a fortnight, the child being healthy and vigorous, the interval may be slightly lengthened through the day, and lengthened to four hours during the night.*

After a month or five weeks it will often, by judicious management, be possible for the mother to arrange to have a moderately long night's rest, uninterrupted. If the child is suckled about 10 or 11 at night, it may be allowed to sleep on till 4 or 5 in the morning, without a further supply of food. If the child is ordinarily strong, the mother will be able, by the exercise of a little patience and perseverance, to gradually train the child to this habit; and its value for herself is very plain. But she will only succeed by herself being strictly regular in suckling the child at the proper times.

Should there be, as there often is, any sufficient reason for a mother not suckling her child, there are two methods of rearing the infant. The one, by many deemed the more preferable method, is to secure the services of a wet-nurse. In many families the expense is a fatal objection to this method. The second method is to rear the child with artificial food, to rear it "by hand," or to "bring it up on the bottle," as people say.

The Choice of a Wet-nurse should be made with care. She should be in evident good health, but should also be carefully examined to be sure that she is free from any communicable disease, like consumption and syphilis. For this purpose her teeth, gums, throat, skin and hair, and glands of the neck should be inspected. It is well also to learn the character of her husband, and his state of health. Her breasts should be firm, and should have the knotty irregular feeling of glandular structure, not fat and flabby. The nipples should be well formed, and free from fissures. In order that her milk should be suitable, as regards age, to the child, she should have been herself confined about the same time as the mother of the child she is about to nurse, and rather later than earlier. Her milk should be examined. It should be bluish-white, sweetish, and should yield on standing a considerable quantity of cream. *The best test of the excellence of the nurse is the appearance of her own child.* If it present any skin eruption, cracks or fissures of the mouth or nostrils, or blotches about the buttocks, she should be rejected.

The wet-nurse should follow the same rules as to frequency of suckling the child as have been laid down for the nursing mother, and her own habits of life must be carefully regulated. Her food should be plain, nourishing, and at regular intervals. She ought not to need stimulants of any kind, neither porter nor beer. She ought to be cleanly in habit, ought to go early to bed, and rise early. She should have stated daily exercise. *Next to the quality of her milk, the quality of her temper is of the most importance.* A bad temper ought to be a fault not possible of being overlooked. It is a strong objection to continuing a wet-nurse if her monthly illnesses return. It ought to be unnecessary to add that the wet-nurse should be carefully and constantly superintended, no matter how trustworthy she may be.

The writer does not agree with the generally accepted view that a wet-nurse is to be preferred to artificial feeding. There are no difficulties nowadays in the artificial feeding of infants that a little patience and intelligence cannot overcome, while there are risks associated with a wet-nurse that can seldom be entirely discounted.

ARTIFICIAL FEEDING.

When it is necessary to bring up a child by hand, the greatest care and accuracy are required in the preparation of the food.

There is now in the market a very large number of foods for infants, to which the mother or nurse who thinks more of her own ease than her child's welfare is apt to turn, because their preparation seems so simple. But there are several serious objections to the use of any such prepared foods. They have a definite composition, which is not always stated, and which, if it is suitable for one age, is not for another. One cannot always have a guarantee that they are quite fresh, and once the package is opened they are apt to undergo changes. They are also comparatively expensive. On the other hand, cows' milk is nearly always available; it is cheap when one considers that a halfpenny's worth will supply the daily amount needed by a newly-born infant for the first week or two; it can usually be had fresh twice daily, and when treated in a certain way it can be kept for a time unchanged. During an experience of twenty-five years the writer has abandoned the use of prepared infants' foods, one after the other, and finds practically no difficulty in so preparing cows' milk as to meet the needs of every child without exception.

For successful artificial feeding the following conditions must be fulfilled:—

1. The food must resemble mother's milk as nearly as possible.
2. The food must be given at stated intervals with absolute regularity.
3. A similar amount should be given at each feeding.
4. Each supply should have the same composition as every other.

The opposite of these conditions is seen when a mother or nurse follows no rule, feeds the child whenever it cries, is never ready, but mixes in a hurry some milk and water, adds some sugar by rule of thumb, and takes a pull at the bottle herself to see that it is not too hot before thrusting the teat into the child's mouth. It is no wonder that children so fed suffer from colics and diarrhœa.

Mother's Milk itself varies in composition. It contains the same ingredients as cows' milk, but in different proportions. These ingredients are:—

1. Proteid or albuminous (flesh-forming) material;
2. Fat in the shape of cream;
3. Sugar in the form of milk sugar (lactose);
4. Mineral substances—phosphate of lime, &c.;

and the proportion in which they are present may be taken as represented by the following percentage figures:—

1. Proteid	1·62
2. Fat	3·14
3. Sugar	6·26
4. Mineral	0·27

Now cows' milk contains much more proteid and mineral matter, a little more fat and much less sugar, so far as mere quantities go, but there are also other differences.

One of the chief of these other differences is that cows' milk tends to curdle in mass, while human milk curdles in fine flakes. But this curdling is the first part of the digestive process, and one can easily understand what an enormous difference it will make to the child's digestion whether the milk it takes at a meal curdles all at once into large pieces, or only slowly into fine flakes. The curdling process is due to the proteid being in solution in the milk and to its being precipitated by the action of the stomach juice. Now human milk undergoes this process more slowly, partly because the proteid is somewhat different in character in human milk, and also partly because human milk is alkaline, while cows' milk is slightly acid. But when cows' milk is largely diluted, and is made also slightly alkaline by the addition of a very little bicarbonate of soda, it is made to coagulate more slowly and in smaller pieces.

Cows' milk, then, can be made to resemble more nearly human milk by dilution with water and by the addition of a little bicarbonate of soda.

But when sufficient water has been added to secure these ends, the mixture contains too little fat and much too little sugar.

This is corrected by the addition to the mixture of fresh cream and a considerable amount of sugar, cane-sugar, or, still better, milk-sugar.

Cows' milk, then, can be made to resemble human milk—

1. By dilution with water;
2. By the addition of cream and sugar;
3. By a small quantity of bicarbonate of soda.

Experience, however, shows that such a mixture is somewhat constipating to many children. This fault is, in a great majority of cases, corrected by substituting pure golden syrup for cane or milk sugar.

One other point remains. When a child is nursed at the breast the milk of the mother passes straight to the child without exposure to the air, and is, therefore, free of those living organisms which exist in the atmosphere and are sown in myriads into any fluid exposed to the air for even the briefest time. An artificially prepared milk, on the other hand, will contain these organisms in an active condition, unless it be boiled, or brought at least near to the boiling-point, and thereafter kept in perfectly clean and covered vessels. The heating, however, tends to add to the constipating effect.

The rules for preparing cows' milk as a substitute for mother's milk will now be clear. Let us summarize them:—

1. A definite quantity of water is added to a definite quantity of cows' milk to reduce the proteid to the proper proportion and to hinder the proteid coagulating too quickly, and in too large pieces, in the child's stomach.
2. A pinch of bicarbonate of soda is added.
3. Definite quantities of fresh cream and golden syrup are added to bring up the fat and sugar to the proper standard.
4. The mixture is brought nearly to the boiling-point.

But it is desirable to give the child the same strength of mixture at each feeding-time. If the supply were made each time the child was fed, the strength would not be so uniform as it would be if the whole day's supply were made at once. Therefore the amount necessary for each day is calculated and made all together in the morning. To secure it from deposit of atmospheric organisms, the day's supply should be kept in a properly scalded jug, carefully covered, in a cool place. As, however, cream is materially altered by heating, and, besides, it rises to the surface on standing, and so the day's supply would have to be shaken thoroughly each time the amount necessary was removed for the child's feeding, it is better not to add the cream to the mixture, but to add the necessary proportion direct to the feeding-bottle each time.

If these principles on which artificial food is prepared are thoroughly understood, we shall be met with the two following questions:—

1. How much does the infant require daily?
2. What is the amount of each ingredient in the day's total?

We shall proceed to answer these questions, but one very important fact must be noted first. The milk of a nursing mother undergoes some slight changes during the progress of nursing, but on the whole the milk does not grow richer. As the child grows older it grows also bigger, and needs a larger supply of nourishment; but this is not met, on the part of the mother, by a milk of stronger and stronger quality; it is met by a simple increase in amount.

If, therefore, one can decide on what should be the standard strength of milk for the infant of one day old, it is not necessary to go on continually changing it, it is only necessary to give more as the child grows; the same mixture will do for the ten-day-old baby, though the latter will take more at each meal. This is a broad statement that is worth remembering, and is not inconsistent with the fact that, as a matter of convenience, it is advisable to increase the strength of the mixture from time to time, for reasons that will be stated immediately.

The Quantity of Food required daily by an infant. This is answered by going back to breast nursing. For the first three days or so after birth the infant gets very little from the mother, and in consequence it falls off in weight. The first day it probably gets no more than 1 or 2 ounces, the second about 5 ounces, the third about 8 ounces, the fourth about 10 ounces, the fifth about 11 ounces, the sixth about 12½ ounces, and the seventh about 13½ ounces, and by the end of the second week about 17 ounces. Thus the total supply for a day will be—

At the end of the 1st week, ...	15 ounces.
,, ,, 2nd ,, ...	17 ,,
,, ,, 3rd ,, ...	18 ,,
,, ,, 4th ,, ...	20 ,,
,, ,, 2nd month, ...	25 ,,
,, ,, 3rd ,, ...	28 ,,
,, ,, 4th ,, ...	30 ,,

Let us take 20 ounces, that is 1 pint, or 2 tumblerfuls, or 4 tea-cupfuls, as the amount to calculate by; the question now is, what proportions of milk, water, &c., are required to make up this 20 ounces?

Proportion of Ingredients in Infant's Milk.—Taking the standard of mother's milk, already stated (p. 563), we should make up a mixture containing about 1½ per cent proteid, 3 per cent fat, 6 per cent sugar, and ⅕ per cent mineral substances. But, as a matter of experience, it is unwise to begin right away with a full-strength mixture, doubtless because there are other differences between mother's milk and cows' milk that cannot be expressed by percentages. Experience shows that what agrees best is a mixture containing about half that proportion of proteid, and every two weeks or so to increase it, till by the end of the third month the child's milk is made half of water, half of cows' milk, with the addition of cream and sugar, and at the end of the sixth month cows' milk diluted with a quarter of water is used. The mixture made for the first week the writer is in the habit of calling **the milk mixture.** Taking it as the standard, it is easy from time to time to strengthen it, and we shall now proceed to give the details as to quantities.

The Milk Mixture for Infants is made by diluting ordinary sweet milk with 3 parts water, adding syrup, a very little bicarbonate of soda, a pinch of salt it is also well to add, and bringing it to near the boiling-point. To allow of loss, 20 ounces are required daily for the first four weeks. Now an ordinary-sized tea-cup quite full is 5 ounces. The directions therefore become as follows:—

Put into a jug
5 ounces (1 tea-cupful) sweet milk,
15 ,, (3 tea-cupfuls) pure water.
Add a heaped tea-spoonful golden syrup,
One small salt-spoonful salt,
,, ,, ,, bicarbonate of soda.
Mix.

Pour this into an enamelled sauce-pan, and bring just to the boiling-point. Transfer it to a clean freshly-scalded jug, cover with a perfectly clean folded towel, and secure the towel by an elastic band round the upper part of the jug. Keep in a cold place.

When the infant's meal is due, remove the towel, see that it is laid down, not on a dirty table, but on another clean towel or on a clean plate, lightly stir the mixture, transfer the required quantity to the clean feeding-bottle, and immediately re-cover the mixture. To the quantity in the feeding-bottle add a dessert-spoonful ordinary cream, dip the bottle into a bowl with warm water long enough to make the mixture barely tepid. Then take up the child and feed it, regulating the speed, so that the milk is not gulped down hurriedly. As soon as the child shows it has had enough and is not keen for more, accept the indication, and put it back in its cot. Immediately empty out anything left, wash out the feeding-bottle with hot water, and then immerse it completely in a basin of water to which a little bicarbonate of soda has been added.

Quantity at each Feeding.—In the first week a child takes 2½ table-spoonfuls (1¼ ounce) each time, the second week about 3 table-spoonfuls (1½ ounce), the third week about 4 table-spoonfuls (2 ounces), each time, the fourth week 4½ table-spoonfuls (2¼ ounces), the fifth 5½ table-spoonfuls (2¾ ounces), and the sixth 6 table-spoonfuls (3 ounces). At the end of the second month it is taking 7 table-spoonfuls (3½ ounces). But if the child be fed regularly and with a properly-made mixture, it will itself be the best guide as to quantity, provided it is not coaxed, by the pushing back of the teat into its mouth, to take more than it really needs.

Tests for Sufficiency of Infants' Diet.—Three tests may be applied to assure the mother or nurse of the sufficiency of the diet:—

1. The infant's temper.
2. The infant's increase in weight.
3. The character of the motions from the bowels.

The Infant's Temper.—If the child is getting enough, and not too much or too little, it should give no trouble: it should sleep most of the time, waking up punctually for its drink, and going off to sleep again afterwards. If it is "a crying child," examine the motions. If they contain little curdy lumps, the child is getting either too much or the mixture is too strong, or the mixture has been improperly made, or the feeding has been irregular. It may be—though this is seldom the cause—it is getting too little. In that case the motions will be healthy, and the child will always be ready for its bottle, and waking up half an hour or more before its meal is due, crying for it.

There are a few children, not many, who cannot take as much at a time as is necessary, and who require it even more dilute than stated. An observant and intelligent nurse will find this out by observation, and try intervals of two hours or so, and smaller quantities. But let it be noted that these are rarer cases, and the usual cause of crying is that the child has had more than it can digest.

Of course, care must be taken that the cause of the child's discomfort is not something quite unrelated to its feeding.

The Infant's Weight should increase at least 4 ounces a week; if it is stationary, still more if it is falling, the feeding is insufficient.

The Child's Stools will always indicate, by the presence of little curdy pieces, if it is being too frequently fed, getting too much at a time, or getting it too strong. These little pieces may be covered over with mucus and stained yellowish green, but if the motion be put into water, the fact that they are little pieces of undigested curd will become clear.

The Milk Mixture is Strengthened at the end of the first month, and a larger quantity is necessary. It should now be made with

1½ tea-cupfuls milk,
3½ ,, water,

and the other ingredients as before, making 25 ounces, or 5 tea-cupfuls.

At the end of the second month,

2 tea-cupfuls of milk,
3½ ,, ,, water;

At the end of the third month,

3 tea-cupfuls of milk,
3 ,, ,, water;

will probably be sufficient.

Other ingredients remaining the same, and the rules being followed as stated on p. 565.

At the end of the fourth month it should be

3½ tea-cupfuls of milk,
2½ ,, ,, water.

At the end of the fifth month,

4 tea-cupfuls of milk,
2½ ,, ,, water.

At the end of the sixth month the food will be made of nearly whole milk, or

5 tea-cupfuls of milk,
1½ ,, ,, water.

If at any time there seems reason to think the child is being scarcely satisfied, it is easy slightly to add to the nourishing quality of the milk by the use of one of three things:

Fine oat flour,
Plasmon,
Sanatogen.

The ingredients of the milk mixture for the day's supply are first measured out and mixed. Then in the case of the oat flour one or two tea-spoonfuls should be boiled for 10 minutes in just a sufficiency of water, and then the milk mixture is slowly added with constant stirring till the boiling-point is reached.

If plasmon or sanatogen be used, it is not necessary to boil it separately. It is only necessary to add one or two or more tea-spoonfuls to the milk mixture and boil all together. These two are milk products; they represent the proteid of milk in fine powder, and their addition to the milk mixture increases the nutritive value of the mixture without adding to its bulk.

But such additions should be made to the milk only if it becomes quite clear that the milk mixture is insufficient for the infant's nourishment. It is here the intelligence of the mother or nurse can be usefully employed.

For every infant varies in the amount and nutritive value of the food it can usefully consume. The quantities that have been stated should be sufficient, and indeed slightly more than sufficient, for 99 out of every 100 infants. But the odd case does arise when it becomes apparent that a richer food is called for. The ways mentioned are the simplest in which it may be supplied.

Exceptions in Infants' Diet are every now and again met with. That of the child, who takes little and that very dilute, and who, therefore, requires to be fed oftener, has been already noted. But there are children with whom it is difficult to make cows' milk agree, because of the rapid curdling of the milk in large pieces. The child may be a perfectly healthy vigorous child, to whom it is difficult to give as much as it wishes because of this peculiarity. If the directions given are carefully followed, the number of such children will be found to be very few, far fewer than most people think. Before deciding, therefore, that cows' milk, prepared as directed, does not agree, let the mother or nurse carefully investigate the preparation of the milk to make sure no mistake is being made.

In such a child the little masses of curd will be found in the stools, and the child will suffer from wind and colic and have violent fits of crying. If such a child has been getting the strengthened "milk mixture" when these symptoms appear, it will be better to go back at once to the most dilute mixture, and to give smaller quantities at shorter intervals. In fact an attempt should be made to find how small a quantity is necessary to avoid the symptoms. The smaller it is the more often it must be given. When the small quantity is begun, also, a tea-spoonful of castor-oil should be given to clear the bowel of the curdy masses. If a quantity is found which agrees, it should be very gradually increased, and the intervals between feeding proportionately lengthened, till the child's capacity to deal with the full quantity at the regulation 3-hour intervals is restored.

If this manœuvre does not succeed, the addition to "the milk mixture" of something which hinders the curd forming in large pieces may get over the difficulty. Arrow-root and all such starchy substances are entirely unsuited for infant feeding, but for this special purpose, *and for this purpose only*, a little may be used. First mix the ingredients of "the milk mixture", but do not heat it. Then boil a small tea-spoonful of arrow-root in the smallest quantity of water that will answer, two or three table-spoonfuls will do. When it is cooked, add slowly with constant stirring "the milk mixture" till the whole is just at the boiling-point. The fine particles of cooked starch prevent the curd forming in large pieces.

The same result may be obtained by using fine oat-flour instead of arrow-root, but it must be boiled for ten minutes before "the milk mixture" is added. Biscuit-powder might be used for the same purpose, or a tea-spoonful of the powder made by rolling a tea-biscuit of good quality into fine powder with a rolling-pin. If the difficulty still persists, "the milk mixture" may be partly digested by the use of what are called peptonizing powders. These are described in Vol. II., p. 137. It is necessary here to note only that the ingredients of "the milk mixture" would be mixed as directed, with this single exception, that one of the tea-cups of water should be boiling. Into the mixture thus made it would be sufficient to stir quarter of a peptonizing powder; the mixture would then be set where it would remain at the heat imparted to it by the cupful of boiling water. After ten minutes it should then be boiled for one minute.

A specially useful preparation for this purpose, and one very easily used with "the milk mixture", is a powder called "Peptogenic Milk Powder". It is sold in wide-mouthed bottles, and a wooden cap for the bottle is fitted to be used as a measure. A capful of this powder is thoroughly stirred into the pint of cold "milk mixture;" the whole is then put into the sauce-pan over a clear *but slow* fire, and stirred till it boils.

Condensed milk may be tried as a substitute for fresh cows' milk. If it is used, it is the *unsweetened brand* that should be made use of. One part of this to 8 or 10 of water represents ordinary cows' milk. Make first, therefore, the quantity, representing a tea-cupful (5 ounces) of cows' milk, by using ½ ounce (1 table-spoonful) of the condensed milk, and making it up to 5 ounces with water. With this go on to make "the milk mixture" as noted on p. 565.

Cleanliness and Accuracy in the making of "the milk mixture" are absolutely indispensable, and also **punctuality**. It is amazing how frequently one sees, in good houses even, the most slap-dash, hap-hazard, untidy, not to say dirty methods followed in preparing the infant's food. Yet the smallest care and method will make the process of the simplest possible kind. The table at which it is made should be clean; a clean towel should be spread on it. [Is it necessary to say that a baby's napkin is not a clean towel?] Everything needful should be arranged upon it—the clean, freshly-scalded jug, the jug of newly-drawn cold water, a clean table-spoon to stir the mixture, a clean tea-spoon to measure the syrup, another for the soda and salt, a clean tea-cup as measure, or a clean glass ounce-measure; the thoroughly cleansed, outside and in, enamelled sauce-pan; the bicarbonate of soda, not in a paper parcel, but in a wide-mouthed, wood-topped bottle; the clean folded towel to cover the jug, and the rubber band by its side—all should be in place before the preparation is begun.

Punctually every morning, at the same hour, the mixture should be made. Probably the most convenient hour would be 9 or half-past 9, so that the fresh days supply is ready to give the first feeding of it at 10 a.m. The other hours of feeding would then be 1, 4, 7, and 10 p.m. If the precautions named have been taken, and cleanliness has been observed, the mixture should keep, and there should be enough for feeding the child, say at 3 or 4 in the morning, and again at 7. But the twenty-four hours' supply may be made in two portions, the first at 9 a.m., enough for four feedings, the next at 9 p.m., enough for other three or four, as the case may be.

A great many attempts have been made to produce a food for infants resembling human milk, Liebig's food for infants, Nestlé's food, &c. &c. As a rule, however, they are all deficient in proteid elements; as a result, although they agree with children, the children are soft, flabby, pale, and deficient in vigour. They have soft, yielding bones, are very open to disease, and have no great power of recovery.

In no sort of food is this defect more marked than in such as arrow-root and corn-flour, and to a less but still a marked extent, in sago, tapioca, rice, barley. Yet it is a popular delusion that arrow-root and corn-flour are good for children, and very nourishing. *They are not so.* They consist almost entirely of starch, which the digestive apparatus of an infant is not yet prepared to digest. They are bland in character, however, and are not irritating, but are only nourishing in proportion to the quantity of milk with which they are prepared. So far as the arrow-root or corn-flour themselves are concerned, a child fed mainly on them would waste, would be literally starved. Several of such artificial foods are noted on p. 136, Vol. II.

For purposes of night feeding, food warmers are employed. For a useful kind see Plate XXXI.—Appliances for the Nursery. It is usual to keep the food in the dish and the light burning beneath it, so that the food is kept warm all through the night. Kept warm for hours at a time the milk is apt to sour. It is better, therefore, to light the wick and allow the food to warm just before it is about to be used, the food being kept cold till then. For a similar reason it is a mistake to fill a feeding-bottle with milk and keep it warm in bed till required. Changes are thus apt to be produced in it injurious to health.

It is necessary again to repeat that milk prepared in one way or another, as noted, is the proper diet, and milk only, for a child up to four and even six months of age, and that, as a rule, if the mother or nurse takes sufficient care in regulating the times of feeding and the quantities, difficulties in the way of digestion will be overcome.

It is also necessary to say again that the utmost care must be exercised in keeping the feeding-bottle, tubes, and teat scrupulously clean. A speck of old milk, left in either, will speedily set up fermentation in the new supply, and derangement of the child's stomach, looseness of bowels, &c., are too likely speedily to arise.

BATHING.

There is certainly nothing which conduces so much to the comfort and health of a child as regular bathing from the first day of its life. The infant should have its first bath immediately after its birth. The bath should be large enough to permit the child to be covered with water up to the neck. The water should be at the same degree of warmth as the child's body; lukewarm is the best description of it. If regulated by a thermometer, it should be about 98° Fahr. The child's head and face should be first washed with the clean bath water, and then thoroughly dried with a soft towel, the child meantime lying on the nurse's lap on a warmed flannel cloth. The child should then be placed bodily in the bath, supported by the nurse's hand and arm, and gently sponged all over. A small quantity of fine toilet soap should be used. Special care should be taken to cleanse thoroughly the fold of skin at the neck, arm-pits, and groins. After the washing the child should be quickly but carefully dried, and then those parts of the skin which rub against one another, the folds of the groin, armpit, neck, &c, should be lightly dusted with fine violet powder. A great many nurses are careless in the drying, thinking the dusting powder is put on for this purpose. This is a great mistake. If the powder is put on the skin still damp it forms a cake; and nothing is more likely to irritate and inflame the child's tender skin and lead to the formation of sores. The skin must be first quite dry, and then the powder applied helps to diminish the friction between the opposing surfaces of the skin. For a similar reason the powder must not be too freely applied, a very fine film of it being all that is necessary.

The bathing process should be performed before a fire, draughts being kept off by a screen.

The newly-born infant often has its skin coated in various places, and specially the head and folds near the joints, with a thick whitish scum difficult to wash off. This is most easily removed with oil, olive-oil, sweet-oil, or butter if no oil is at hand. The nurse takes a little oil in the palm of her hand, and rubs it over the part gently but firmly till a sort of lather has been produced. A sponge with clean water and a little soap will then readily cleanse the skin. The eyes of a newly-born infant should be specially looked at, every particle of matter being removed with a clean sponge and pure warm water. Any appearance of matter coming from them within the first few days after birth should cause special attention to be directed to them. (See INFLAMMATION OF THE EYES OF NEWLY-BORN CHILDREN, p. 595.)

Children should be bathed twice daily, in the morning immediately after rising and in the evening before going to bed, and *always at the same hour*. In fact if the same regularity advised in regard to the giving of food be practised in regard to the bathing, it will add much to the comfort and general health of the child, and will do a great deal towards making the child bright and active throughout the day, and towards securing for it sound refreshing sleep throughout the night.

The evening bath should be the principal one of the day, the child's body being then well washed all over, soap being used; the morning bath need not be much more than a dip in plain water, and sluicing with the sponge. As the child grows, the warmth of the morning bath may be gradually reduced a little, and at six months the child, if it is healthy and vigorous, may be freely sponged in the morning with nearly cold water if the weather is warm. The cool water should only be applied with the sponge, the water in the bath in which the child is set down should be warmer. After the cold sponging the child's body should be well rubbed with a fine towel; and if there is any sign of chilliness or blueness of the skin, the cold sponging should be stopped and not used again till the child is older. No mistaken notion of "hardening the child" should lead to persistence in the use of water manifestly colder than is consistent with the child's comfort.

Food should be given *after, not before* the bath.

Many mothers and nurses abstain from giving the usual bath for very trifling reasons. If the bath is properly given, and if proper care is taken to guard against chills, which ought always to be done, there are very few circumstances, indeed, in which it can do any harm. On the other hand, at the outset of many childish complaints, the warm bath is of the greatest possible benefit. It not only cleanses the skin, and stimulates the activity of the sweat-glands in removing waste substances from the blood, but it causes relaxation of the blood-vessels of the whole surface of the body, and consequently brings the blood to the skin in greatly increased quantity, to the relief of deeper parts.

CLOTHING.

Clothing has for its object the maintenance of a certain regular degree of warmth, and its nature and amount ought, therefore, to be determined by the external temperature. It should vary, that is to say, with the climate and the season of the year. In Section XX. it has been explained that the skin plays a very important part in maintaining a regular bodily temperature. When the heat of the atmosphere is higher than the proper bodily heat, it has been explained that the body heat is kept at its due level by the blood flowing in larger quantity to the skin, and by heat lost in evaporating increased perspiration; and when the heat of the atmosphere is less than that of the body, a lowering of the bodily temperature is to some extent prevented by the contraction of the blood-vessels of the skin, diminished sweat, and consequently a diminution in the loss by evaporation. In climates where the heat of the atmosphere is very different from that of the human body, and where the variations are great, men must come to the aid of the ordinary healthy processes of the body. In warm climates clothing is used which reflects, throws off, as much as possible, the heat of the sun, and is, at the same time, fitted to permit of free perspiration, while in cold climates clothing is used to retain the heat of the body and prevent it passing off. While infants' dress ought to fulfil the same purposes, it must be remembered that the heat-regulating apparatus, so to speak, of the child's body is not yet in full working order, and the child is consequently much more sensitive to changes in the surrounding atmosphere, and much more strongly affected by them. A slight change in the heat of the atmosphere, to which a man's body so readily adapts itself that he is barely conscious of it, may strongly affect a child; and this should always be remembered by mothers and nurses.

The second special point to notice regarding infants' dress is that it should be so put on as to interfere as little as possible with all natural movements. This requirement is not satisfied when free movement is permitted to arms and legs; care must be taken that the movements of breathing are not hindered. Most of mothers and nurses make this mistake at the very outset. They apply the binder so tightly round the child's belly and chest, in the delusion that its back is thus supported, that its breathing is greatly impeded; and often permanent injury is inflicted on the lungs. Acting under the same mistaken idea they encase the child's body in stays (so-called), and with a multiplicity of other wrappings reduce the infant to a condition of miserable bondage.

A third point worth remarking upon is that an infant's skin is not only very sensitive to changes of temperature, but is also very readily irritated in various ways. The mere mechanical irritation produced by the rubbing of rough cloth will often cause the appearance of a rash on the skin, and will at least be a source of great discomfort to the child. This is a cause of annoyance not to be overlooked in dealing with a fretful child. For this reason the child should have next its skin some very fine soft material. For the same reason wet napkins should be quickly removed, as well as any other article of dress that has become damp. The skin is very speedily inflamed, and cracks and fissures are very readily caused, by contact with wet clothing, especially when wet with irritating material such as that of the discharges. Before replacing dry napkins the skin should be carefully dried and dusted, if previously sponged so much the better. It may be added that the napkins or diapers should not be washed in water containing soda.

Pins, even safety-pins, should, as far as possible, be avoided in an infant's dress. Extreme restlessness, crying, and sometimes even convulsions have been caused by carelessly applied pins, whose points had worked themselves into the child's skin.

What manner of child's clothing, then, best fulfils the conditions that have been set forth? Flannel ought, undoubtedly, to form the chief part of an infant's dress, a long-sleeved flannel gown from the neck downwards being the principal garment. As, however, the child's skin is apt to be irritated by rubbing against the flannel, a shirt of fine lawn is usually put on next the skin. It is customary also for a roll of flannel—a binder—to be wound round the belly. During the early weeks of the child's life this is valuable, by giving protection and support to the navel. *But it is almost constantly too tightly drawn*, and seriously interferes with the action of the chest and belly, greatly impeding breathing. It should always be so slack that the hand can be readily passed between it and the skin. The use of the binder should not be continued longer than six or eight weeks. After that time it should be daily made narnower and shorter till in a few days it is entirely given up. The flannel dress should be fastened by means of buttons or tapes, even safety-pins being not devoid of danger, and it should extend for 10 inches or so beyond the feet to keep the legs warm. It should never be so tight-fitting at any part as to limit freedom of movement. A light woollen shawl, to be thrown over the child when it is being carried from one part of the house to the other, completes all its necessary clothing. The head needs no special covering indoors, either by day or by night. When the child is taken out it requires a covering for the head, a soft, light woollen hood being preferred, and it also needs an extra wrap, a woollen shawl being the best. If a cloak is used, the mistake should not be made of fastening it on by tying round the neck only, half strangling the child, as it too often does. The thickness and closeness of the material forming the added garment should depend upon the weather and season of the year.

About the third month of life, when the child begins to exercise its limbs more freely, its clothes are usually shortened. Stockings and soft pliable shoes become necessary. The clothing at this period commonly consists of a linen, cotton, or flannel shirt next the skin, of a pair of stiff-starched cotton stays, of a flannel petticoat made with a body, an outer cotton one, and of a dress with short sleeves. There are some objections to be taken to this arrangement. The shirt should always be of flannel, unless that has already proved too irritating. The stays are worse than useless, they are positively injurious, a hindrance alike to free movement and free growth. There is no justification of any kind for retaining them. Instead of each petticoat having a body of its own, or being simply buttoned at the waist, a light flannel body should be made separately. Round the waist it should be provided with buttons to fit corresponding button-holes in the petticoats. With this arrangement, if one petticoat be wet it can be removed without undressing the child. From the waist-band of this body suspenders for stockings can be attached. The dress should always have long sleeves, and should not be low-necked.

For night a woollen night-dress should be provided, but no night-cap or other covering for the head.

EXERCISE, AIR, AND SLEEP.

Even the youngest infant derives great benefit from such exercise as is possible to it, as it lies free and unrestrained on its mother's or nurse's lap. For this reason the washing and dressing of a child should be leisurely rather than hurriedly performed, provided care be taken against the risk of cold. Even the youngest infant should be accustomed to the open air, carried in its nurse's arms. The daily airing should be a regular ceremony, on dull as well as on bright days. The child should have extra clothing according to the season and the state of the atmosphere on the particular day; and the face should be protected by a light veil. With such precautions the child will not be affected by moderate changes of weather; and it will seldom be necessary to prohibit its going out. At first, of course, the infant is to be taken into the open air for only a few minutes at a time, fifteen to twenty, and the time is to be gradually extended as seems desirable, and according to the state of the weather. Carrying in the nurse's arms is better than wheeling in a perambulator. The motion of the perambulator is not so agreeable, and the child is apt to become stiff and chilled in a constrained position.

As regards rest, the infant passes most of its time asleep, and it is, therefore, important to make no mistake regarding its bed and bed coverings. From its birth the child should sleep in its own bed and *not with its parents or nurse.* A wicker basket, lined inside, provided with a firm mattress, covered by a small blanket, a small, not too soft, pillow, and a miniature pair of blankets and down quilt, form a very comfortable sleeping-place. The bassinet should be raised off the floor. Children are commonly kept too warm in such little cots, coverings being heaped upon them, curtains being drawn round their heads, so that they are often completely covered up, no regard being paid to the means by which fresh air is to reach the child. As a result, when the child is lifted out of the bed it is streaming with moisture, its head being bathed in perspiration. Care is certainly to be exercised to prevent draughts sweeping below the crib or round its head, but the basket should be freely open in front towards the child's face, which should never be covered up. Perspiration bursts out over the child's head if the pillow is so soft that the head sinks down into it. Down pillows and mattresses are, therefore, bad. The pillows and mattresses should, on the other hand, be firm enough to offer sufficient though gentle support to the child.

The excessive warmth to which the child is usually subject in its cot is not so injurious even as the bad air which it is so frequently caused to breathe. Not only, therefore, must curtains not be drawn round its head, but care should be taken to ensure that the room in which it sleeps is duly and properly ventilated, but so as to avoid draughts. The opportunity should also be taken whenever the child is out of the apartment to air it properly. The room should be directed to the south, if possible, and air and sunlight should have free access to it, for air and light are as necessary for healthy growth as food. It is always advisable to regulate the warmth of the room by means of a thermometer, instead of leaving it to the feeling of parent or nurse, and the heat should be kept as regular as possible, the mercury standing at 65° Fahr.

USE OF MEDICINES.

If infants are properly managed they require little medicine of any kind. But with many people it is a matter of custom to give a dose of castor-oil, or magnesia, at regular intervals, every two or three days, or once or twice a week. According to their view, the child could not possibly continue well without such meddlesome interference. From the day of its birth onwards, for the slightest reason, and frequently without reason, the child is dosed with opening medicine. The result is that irregularity of the bowels is set up, and a great amount of harm done which it is very difficult to rectify. Now a healthy infant needs no medicine whatever as a matter of course, and the giving to it of medicine of any kind ought to be an unusual rather than a customary practice.

The first milk drawn from the breast of a nursing mother is of a peculiar character and is called **colostrum**. It has an opening effect on the child's bowels, and the first material passed from the child is usually of a dark-brownish colour. There is, therefore, no necessity for the newly-born child, that is being nursed by its mother, getting opening medicine, for that has already been provided for *by nature*. This is one of the reasons why the child should be put to its mother's breast shortly after birth. After this the child's bowels ought to move naturally twice or three times in twenty-four hours, and the stools should be of the thickness of thin mustard, of a light yellow colour, free from lumps or curdy-looking masses, and passed without pain or disturbance of any kind. Frequently the motions are greenish, very offensive to the smell, and lumpy with white portions of curd, and to remedy this it is usual for the nurse at once to resort to the use of castor-oil, magnesia, or other medicine of a like effect. Now the cause of this condition is commonly bad methods of management. The child is getting too many drinks, or too much at a time. The curd is simply portions of undigested milk passing unchanged through the bowels, because the bowels are unable to digest the large quantity passed into them at one time. The remedy, at least in the first instance, is to correct the bad nursing, to give the child the breast less frequently, or to give it less at a time, or to do both these things. If the mother or nurse will really put it to herself that she is to blame for the state of the child's digestion, and will correct the mistakes she is making in suckling, the natural condition may be restored without the use of medicine. One of the results of this improper feeding is that the infant is troubled with wind and is much pained. For that reason, also, the mother hastes to give medicine instead of setting right her improper ways of nursing. If, however, the bowels continue for two or three days in this state, and the child is very fretful and uneasy, it may be desirable to give one dose of medicine, effectually to clear out the bowels, and permit a fresh start. For this purpose one or two tea-spoonfuls of castor-oil are the best means. But the mother must not forget that the relief will only be temporary unless she takes care to manage the child better for the future. The same general principles should be the guide in rearing a child that is being brought up on artificial food. Here it may be necessary to give medicine to secure a motion within the first two days after the child's birth, because it is not getting the benefit of the first milk of its mother. Castor-oil is here again to be given, and thereafter regularity of the bowels is to be secured by attention to the feeding rather than by any giving of drugs. There are numerous cases where from its birth the child exhibits a tendency to costiveness; the proper methods of treating these cases are mentioned further on (p. 605). *The rule to be remembered, however, is that regularity of movement of the child's bowels is to be secured by proper feeding and not by medicines.*

Opening medicines are also the common resort when a child seems troubled with any irritability of the stomach. If it vomits its milk, and specially, of course, if this happens frequently, it must be dosed with some drug or another. Here, again, in all probability the fault is the mother's. It is commonly an overloaded stomach that is indicated; the child is allowed to take, or is forced to take, too much milk. Perhaps the mother's breasts are very full, and the milk flows so freely that the child can scarcely drink fast enough, and gulps it down, or perhaps the mother puts the nipple again and again into the infant's mouth, and encourages it to take more, when by withdrawing its head it has already indicated its satisfaction. In such cases the vomiting is simply nature's method of disposing of the excess. When mothers see this, their business is to try to make the child drink more slowly, to take away the breast when they think the child has had enough, and never to urge it to take an extra supply. As soon as this has been done, probably the vomiting will cease. If, however, medicine does seem needful, then it ought to be a simple dose of one or two tea-spoonfuls of castor-oil, or two or three tea-spoonfuls of fluid magnesia repeated occasionally for a day or two.

Many people find it very difficult to give medicine to infants. The child can easily be held on the left arm, propped up with its head resting on the shoulder and held so by the arm gently pressing the head against the person's chest, the hand of the same arm being brought round in front to hold down the infant's hands. The medicine is taken in a small spoon in the right hand, and gently, but firmly, introduced into the mouth far enough to place the medicine well back on the tongue. If this is properly done the child cannot help swallowing it. *Only a small quantity should be* taken on the spoon at a time, about a quarter of the spoonful, and when that has been disposed of a little more is given, till the necessary quantity has been swallowed.

A second thing which some nurses are too ready to do is giving the lately-born infant a little gin-and-water or a little spirits of nitre and water, because the child has not made water, or what they think not enough. This must never be allowed. A small quantity of water may be made but be unnoticed, because of being soaked up by the cloths. Even though it is quite certain that no water has been made, drugs must not be given. A pad of flannel wrung out of moderately warm water and placed over the lower part of the belly and between the legs will usually be sufficient to encourage the flow. This application may be repeated for several times. Nothing else should be done without medical advice.

Stimulants of any kind should never be given to children by parents or nurses. A doctor may find it advisable to administer them in certain cases, but on no account should others employ them without medical orders.

Some form of stimulant is often given to dispel wind, but there are some harmless drugs, such as dill water or essence of anise, which are equally satisfactory in their action. The method of giving them is mentioned on p. 601. But again it cannot be too strongly insisted on that flatulence and similar disturbance of the bowels are due most frequently to bad management in suckling or feeding, and that that evil should be rectified. The practice of giving to children, and specially to infants, what are insinuatingly called *soothing medicines* cannot be too strongly condemned. The effective ingredient in the most of these compounds is *opium* in some one of its forms. Laudanum itself, the tincture of opium, is frequently given on sugar by unscrupulous nurses or careless mothers, to quiet a fretful child, whose pain, restlessness, and sleeplessness are due to wretched mismanagement or gross inattention. Even mothers who would not dream of giving laudanum or opium to any of their children are glad to make use of preparations in which the opiate is masked by some special name, such as Mrs. Winslow's Soothing Syrup, Godfrey's Cordial, Dalby's Carminative, syrup of poppies, &c. &c. In each of these it is the contained opium that produces the so-called soothing effect, and each is capable, if used in sufficient quantity, of introducing a "quietness" that will not again be broken. *One drop* of laudanum has killed a child, and numerous cases of infants' deaths have been reported in medical journals from the use of Mrs. Winslow's remedy, and from such preparations. Medical men themselves are extremely chary of administering opiates in any form to young children, even in cases of serious disease, where their use seems demanded, and when they do feel compelled to use them they are extremely careful in prescribing the dose and in watching its effects. *Children are extremely susceptible to the action of opium.* This must never be forgotten, for of some other drugs, of which *belladonna* is a good example, they can "stand" a larger quantity than most grown-up persons It ought then to be a rule, never departed from that neither opium nor any of its preparations, nor any compound in which it exists, is ever to be administered by mother or nurse to a child. Mothers who intrust their children largely to the care of nurses cannot be too careful in seeing that the nurse does not *secretly* employ such remedies to give herself greater ease and convenience by drugging her charge to sleep.

To sum up, the only medicines parents or nurses need have at hand are castor-oil, magnesia, and dill water. If they are kept at hand in case of being required, they should, nevertheless, be sparingly used. The child, it may again be repeated, ought not, in ordinary cases to be *restored* to a proper condition by the use of medicines, but ought to be *kept* in a healthy state by proper feeding and general careful and watchful management.

PREMATURE CHILDREN.

It is only necessary to say a word or two about the extra care required for children born before full time. The more near the infants are to the full period of nine months, the greater is the likelihood of careful nursing enabling them to survive. It is a vulgar notion that a seven months' child has a better chance of continued existence than an eight months' child. This is not so. A child that has passed eight months within the womb is in every way more developed than one that has passed only seven months, and its chance of survival is consequently proportionately increased. The chance of a child born before the seventh month is comparatively small. Nevertheless there are numerous cases on record of infants, born between the sixth and seventh month of intra-uterine life, surviving and thriving satisfactorily. The two difficulties are those of feeding and keeping warm. The child is often too feeble to suck, and artificial feeding is necessary, because the mother has no milk. If the child can be made to suck, milk prepared as directed on p. 565 should be given from a feeding-bottle. To aid the child a small teat should be used, and the nurse should see that the milk can be drawn easily. The child should take from two to four table-spoonfuls at one time, and should get a drink at intervals of an hour and a half to two hours, and more frequently if a less quantity is taken at each time. If the child cannot suck, the milk must be given with the spoon, and it is better to give small quantities at frequent intervals, one to two table-spoonfuls every hour, than to attempt to give larger quantities less frequently. With premature children the difficulty of maintaining the bodily heat is great. To secure this it is sometimes necessary to surround the child, face excepted, with cotton-wool. Care must also be taken with the skin, which is very tender, easily ruffled and inflamed.

VACCINATION.

This is compulsory by law in Great Britain within the first six months of infant life. The purpose and value of vaccination have been fully discussed on pp. 526–530. It may be advisable to re-state here that a child should be vaccinated between the second and fourth month after birth, before teething begins, but that if small-pox be prevalent at the time, and if there be any danger of infection, it cannot be vaccinated too soon. *There is no risk at all to be compared to that of catching small-pox, in vaccinating even the day after birth.* If the vaccine matter is taken from a healthy child on the eighth day after its inoculation, and if only lymph and no blood be taken, there can be no risks whatever of transferring any disease. All risk is got rid of by the use of calf-lymph, now easily obtained everywhere. Further, the extremely painful, red, and swollen arms that one occasionally sees are in most cases due to the carelessness of the mother or nurse in not properly guarding the arms from injury by rubbing or in other ways, and specially to badly-adapted clothes which compress the parts at the arm-pit and lead to inflammatory swelling of the whole arm. The full measure of safety is secured when four good vaccination marks are produced. The mother, therefore, should allow the child to be vaccinated on four "places" if she wishes the utmost benefit of the operation. Many doctors vaccinate only on two "places", and if the district where the children live and are likely to remain is commonly free from the disease, so that the risk of infection is slight, two marks may be satisfactory enough. Vaccination on only one place, however, is too little to be satisfied with. If, however, there is any risk of infection in the neighbourhood where the child lives, or if there is any likelihood of the persons removing to any district where there is risk, vaccination should be performed on four "places" to secure the greatest amount of protection. If children are well managed they should give comparatively little trouble during the period when the vaccine is operating on the body. Careful dieting, the usual attention to bathing and cleanliness, attention to the bowels, and care to prevent injury and irritation to the arm ought to ensure little disturbance. If the child suffers at all it will be between the seventh and tenth days, when it may be hot and restless, and the bowels slightly disordered. A tea-spoonful of castor-oil, or three or four tea-spoonfuls of fluid magnesia is all the necessary treatment. The heat of the vaccinated part may be soothed by placing lightly over it, if it seems needed, a piece of lint soaked in cold water, and keeping it soaked. If the lint is allowed to dry, it will adhere to the part, and attempts to detach it will cause still more pain than before.

Some children, comparatively few, however, fail to take the vaccination. By the Vaccination Acts the operation must have been performed three times and failed each time, before the child is declared insusceptible. If this has been done, the doctor will give a certificate to that effect. But it would be well, if the operation had failed twice with lymph obtained in the ordinary way, that it should be tried the third time with calf lymph.[1]

Should a child not be in good health, a medical man may, if he deems it advisable, postpone the operation to a period beyond the legal six months by signing a certificate to that effect.

Revaccination is considered on p. 530.

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[1] There are several associations now in London for the supply of pure vaccine lymph, calf lymph as well as human lymph. The writer has had every reason to be satisfied with calf lymph obtained from the Association for the Supply of Pure Vaccine Lymph, 12 Pall Mall East, London, of which Mr. Ed. Darke is secretary. Quarter-tubes, sufficient for one child, are obtained through the post for *7d.*

THE MANAGEMENT OF CHILDREN BETWEEN THE SIXTH MONTH AND THIRD YEAR OF AGE.

FOOD.

Breast-Feeding.—Up to the sixth month the child has either been nourished entirely by the breast milk, or by milk food given through a bottle, or by the breast milk supplemented by the bottle food.

By this time it may become necessary to make considerable additions to the diet, though there are plenty of cases where the mother is quite able to nourish the child from the breast exclusively up to the ninth or even twelfth month. If the mother requires only a little assistance to continue suckling the infant satisfactorily, that assistance may be given in the form of bottle food once or twice daily. The time or times when the bottle is given may be arranged to suit the mother's convenience and duties. But whatever hours are arranged should be rigidly adhered to.

The bottle food should consist of "the milk mixture" of the strength and amount stated for a child of six months. But if, up to this date, the child has been wholly nourished from the breast, this strength and quantity should not be given right away; a considerably weaker strength should be given for the first day or two, till the child's stomach becomes used to the change. Begin, let us say, with the strength and quantity suited for a child of three months; after two days' experience of its suitability give the strength and quantity suited for a child of four months. If this agrees, after another couple of days give the next strength, and so on.

If experience shows the strength and amount of "the milk mixture" suitable for a six months' infant to be barely sufficient, then add the oat flour, or plasmon, suggested on p. 566, and, beginning with one tea-spoonful, find how much seems to satisfy the child best.

On the whole the addition of oat flour is best, because as the child grows older, and needs a more nourishing diet, the oat flour can gradually be increased, till the child gets so accustomed to it that one may give it no longer through a bottle, but with a spoon in the form of oat-flour porridge.

The breast-fed child is thus gradually prepared for weaning. Beginning with one bottle a day, let us say, it comes to have two, three, or four, according as the capacity of the mother to continue nursing gradually diminishes. So that by the time the child is nine or ten months old, nursing may be restricted to only a portion of the twenty-four hours, night only perhaps, while the child gets artificial food as indicated during the day.

If the mother objects to a feeding-bottle at all, it is, of course, quite easy to accustom the child to be fed with a spoon. But "the milk mixture" should be used, as before, strengthened or not with plasmon or oat flour. Indeed, if a child has been suckled up to six months, it is a pity to begin with a bottle, for at that age an infant can with little difficulty be taught even to drink out of a cup.

The infant will thus arrive at the age of ten or twelve months, being partly nourished from the mother's breast, partly by "the milk mixture," strengthened, more or less, with plasmon or oat flour, given through a bottle, or by a spoon, or out of a cup. By this time, probably the child has one or two meals a day made of oat-flour porridge, such a meal being given by a spoon along with "the milk mixture" suitable for a six-months-old child. A sufficient meal at such an age would be a small saucer of well-boiled oat-flour porridge (boiled with water) and barely a tea-cupful of "milk mixture". But a child who has been properly reared will itself give the best indication of when it has had a sufficient meal, and its appetite, if never forced, may be safely taken as a guide.

The regularity, already insisted on, as to times of feeding, quantities, character of food, &c., must be scrupulously maintained.

Further, if the child has become accustomed to the thicker spoon-food, rusk may be used as a substitute for the oat flour. If so, the heated milk mixture is poured on the rusk, and the whole beaten to a pulp.

In the case of such substantial meals, a longer interval should elapse between one meal and the next.

The diet of a child of between ten and twelve months, not yet weaned, comes therefore to be something like the following:—

- Between 4 and 5 a.m.: A drink from the mother.
- 8 a.m.: Oat-flour porridge, with 4 ounces "milk mixture" of a strength suitable for a six-months' infant.
- 12 noon: The child may be nursed, or may get a bottle of "milk mixture," strengthened or not, as seems necessary, by oat flour or plasmon.
- 3 p.m.: A bottle similar to what may be given at 12.
- 6 p.m.: A bottle as at 3 p.m.
- 9 p.m.: Oat-flour porridge as at 8 a.m.; or rusk and milk mixture.

This child will probably sleep till 3, 4, or 5 in the morning, and when it wakes will be nursed. If the child has been well trained, and the food is given late at night, the mother's rest should not be disturbed more than once; and the above arrangement also frees her at mid-day for other duties. If she still produces so much milk that her own comfort demands more frequent nursing, then suckling at 6 p.m. may take the place of bottle.

Weaning should be effected when the child is ten or twelve months old, the exact time being dependent upon the health of mother and child. It will be begun earlier if the mother is suffering from nursing, and delayed till later if the child is weakly and the mother able to bear prolonged nursing and having good milk. The period named is generally chosen because the child usually has about that time an interval of rest between cutting the front teeth and the first of those at the back. It is often a process involving some trouble to the mother and discomfort to the child, but, if the above directions as to feeding have been observed, the child will really have been in preparation for it since the sixth month, and much of the difficulty will be overcome. Weaning should not be allowed to take place if the child is suffering from the irritation of late teething, from any cold, or feverish attack, or trifling illness, but the mother should wait till that has passed off. The process should be performed gradually; as the breast-milk is withdrawn its place should be supplied by other appropriate nourishment, such as has been already sufficiently indicated.

Artificial Feeding, after six months, should occasion no difficulty whatever, if the directions given up to that month have been carefully followed.

"The milk mixture" suitable for a six-months-old child is gradually strengthened by the use of oat flour or plasmon or sanatogen just as indicated on p. 566 Soon this becomes too thick to pass through a bottle, and then the child is accustomed to the spoon and the oat-flour porridge, or rusk-and-milk mixture, as noted on p. 575, varied with less thickened "milk mixture" given by bottle or cup.

When thicker spoon-food is given only once daily, it is best at the bedtime of the mother or nurse, for then the child is likely to sleep all night, or, at the most, to require only a sip of the "milk mixture" from a cup.

For an artificially-reared child, between ten and twelve months old, a diet, suitable to the child and convenient to mother or nurse, would be—

- 6 a.m.: "The milk mixture", of the strength suitable for a six-months-old child, thickened or not, as seemed necessary, by plasmon or oat flour, and given through bottle or by cup. (This would have been prepared the previous night.)
- 9 a.m.: The same as at 6 a.m., but freshly prepared.
- 12 noon: Oat-flour porridge and "milk mixture."
- 4 p.m.: A bottle of "the milk mixture" prepared in the morning.
- 7 p.m.: The same as at 4 p.m.
- 10 p.m.: Oat-flour porridge or rusk and milk (as noted on p. 575).

The fuller meal, given the last at night, is likely to secure an all-night's sleep, but there can be no objection to giving it at 7 instead, just after the child has been bathed for the night, and then delaying the final meal—taken out of bottle or cup—till the child wakes spontaneously about 10·30.

But there is no magic in the hours or the order named above. One arrangement will suit one child better than another, and different arrangements may suit the child and be more convenient for the household in general.

But it is most important that there be no changing of arrangements from day to day, or from time to time. Whatever arrangement is found best must be adhered to, so that it becomes part of the child's habit.

Another point is that a sufficient interval must follow each meal before the next is given, three hours in case of a bottle meal, and four hours when the meal is more substantial.

Diet after the First Year requires the introduction of further variety. From this point we need no discrimination between infants suckled by the mother and those hand-reared.

The principles that have been followed up to this point must not be abandoned, viz.:—

(1) Changes are not to be made suddenly.
(2) Fixed hours must be maintained.
(3) The interval between one meal and the next must be sufficient to permit the stomach to rest, after dealing with one meal, before being called on to digest another.

Inasmuch as, in most households, 8·30 or 9 a.m. is the earliest hour at which the infant's first meal can be conveniently prepared, and the infant will probably want some nourishment earlier than this, 9 a.m. may be taken as the hour for breakfast, and a light meal can be given at 5 or 6 a.m. if the child wakes for it. This early meal can be given out of a bottle, or by this time the child may have been taught to drink out of a cup, and the meal will consist of ordinary milk, which has been heated the previous evening, as much for preserving purposes as anything else, and to which may have been added a little oat flour, plasmon, Benger's food, or similar preparation. The bill of fare becomes as follows:—

6 a.m.: Cup of milk, slightly modified.
9 a.m.: Oat-flour porridge and milk; or rusk and milk.
1 p.m.: A tea-cup of thin chicken or mutton soup with stale bread broken down into it, and beaten into a pulp; or a cup of milk with a little milk pudding.
5 p.m.: Milk with bread broken down in it, or rusk, or a tea-biscuit.
9 p.m.: Rusk and milk; or porridge and milk.

If porridge is given in the morning, the last meal may be rusk and milk; if the latter is given in the morning, the last meal may be porridge.

The soup is not to be of strong stock. It should be only the thin of such an ordinary soup or broth as commonly forms a part of a mid-day nursery dinner. For instance, every thrifty housewife knows how pleasant and tasty a soup can be made from the carcase of a fowl, the meat of which has been mainly consumed, with the addition of rice and parsley. Well, the thin of such a soup, not strained, not skimmed of fat, but simply lifted with a ladle, with bread crumb mashed up in it, makes an excellent meal for the one-year-old baby; so also does the thin of an ordinary Scotch broth with bread.

How often has one, investigating the cause of some childish ailment, hunting for the reason for some troublesome skin eruption, and enquiring into the diet given to an infant, to listen to the tale—the silly tale—about the pound or two of veal and beef, or the plump tender fowl "boiled down to rags," to yield the single cupful of soup, clarified and skimmed and strained, and so strong that when cold, it could be "cut with a knife"! How impossible to get the mother or nurse, who is so ignorant as to be capable of such foolish waste, to understand that such a cupful is not only of practically no food value, but is actually a species of poison! That this is an accurate way of putting it, any intelligent person will understand by reading what is said of foods in the second volume of this work.

Now the diet noted above is quite suitable for several months, with only a little variety or increase in the 1-p.m. meal. If, as suggested, the thin of an ordinary broth or soup has been used, which will, of course, contain less or more rice or barley and other vegetables, then gradually more and more of the rice and other vegetables will be lifted with the thin for the infant, until, at about fifteen or from that to eighteen months, the whole broth or soup with the vegetables is being given, with certain exceptions only. The exceptions are that whole peas would not be given, nor carrot, turnip, or potato in pieces. Pieces of turnip or potato need not be removed; they need only to be broken down to pulp with the spoon, but pieces of carrot should be rejected. Care must be taken that all the vegetables are finely chopped and thoroughly cooked.

Further, a thick soup may be substituted as soon as the child's stomach has become used to vegetables, such as pea, potato, or lentil soup, or a milk soup, or rice soup. In all these cases the soup must not be made of a rich stock. As regards the milk pudding used now and again as a change on the soup or broth, rice is the most suitable thing to make it of, and it should contain egg. It would be only an ordinary milk pudding, such as would be made for an ordinary nursery meal, that is, enough pudding would be made with one egg for three persons. The infant would only get a small portion of this with a cup of milk.

On any day the infant had soup, a share of any milk pudding, made for other children, might be kept for the infant, as a change on its 5-o'clock bread-and-milk meal.

Pudding made with egg proving suitable, at about eighteen months a lightly-boiled egg may be given for dinner, with bread and butter and milk.

At about the same age, also, a well-boiled, mealy potato mashed with a little butter, or gravy from meat, with a little added salt, makes an excellent change for dinner, with a cup of milk, other meals remaining as stated.

The earliest date at which fish or meat should be given to children is about two years. At this age it should be given only very occasionally, say once a week, and it should be lightly cooked and finely chopped up. Lightly-steamed mince may be tried to begin with, only a small spoonful, mixed up with well-mashed potato. Fish or chicken may be used in the same way. But by this time the child should have been taught to chew properly. This important lesson may be begun by substituting bread and butter, with milk, for the morning or afternoon meal; and if the child is taught thoroughly to masticate bread and butter, it will be prepared for a meat meal.

At two years of age the early-morning drink will have become unnecessary, and four regular meals a day will be sufficient as follows:—

8 to 9 a.m.: Porridge and milk; or bread and butter and milk, hot or cold according to the season.
12 noon: Soup or broth and bread; or milk pudding made with egg, eaten with milk, and bread and butter or a biscuit; or potato with a little fish, chicken, or meat; or an egg, bread and butter, and milk.
4 p.m.: Milk, bread and butter; or milk pudding and milk.
8 p.m.: Rusk and milk; or milk and a biscuit.

At the afternoon meal the bread may be spread with jelly, honey, or syrup.

Some regard should be paid in dieting to the relation of the meals to one another. If the breakfast consists chiefly of porridge and milk, or bread and milk, the dinner should contain a good proportion of animal food in the shape of egg, fish, or butcher-meat of some kind. For it must not be forgotten that at this age the child cannot obtain sufficient flesh-forming material from bread, and still less from rice, sago, corn-flour, or such substances. It cannot even drink sufficient milk to supply this want. The result will be that, if animal food is not supplied, the child will be soft, with soft bones and flabby muscles, wanting in sustained energy. The necessary animal part of the diet should therefore be made up at dinner, and if, owing to the nature of this meal, on some occasion it is in deficient quantity, it may be made up at tea by a part of an egg or a whole egg. Animal food should be given preferably at mid-day. The meat should be boiled or roasted. Salted meats, pork, veal, and lamb are to be avoided. A small quantity of vegetable may also be allowed when the child has passed two years of age, potato as already mentioned being given earlier than that age, if not new and if mealy and well mashed; but after two years, turnip, and cauliflower, well boiled, may be permitted in small quantity, cabbage or green vegetables also, but they must be finely chopped and thoroughly cooked. Soft green peas may be allowed. Some cooked fruits —stewed apple or prunes — will usually be relished given with well-boiled rice, but uncooked fruits are injurious, except the orange when in season, the child being taught to reject the skin and seeds. Pastry and nuts are to be avoided.

The diet recommended will strike many people as generous, and liable to lead to overfeeding. It will not do so if the child receives its meals at regular times, and does not get additional food at odd moments. If a child has its regular meals it will take at each what satisfies it and no more, provided an undue variety of dishes be not produced to stimulate its appetite. But if in addition to its own meals it is permitted partly to share its parents', then overfeeding or digestive troubles will likely arise. As great an evil is the giving of sweet biscuits, pieces of bread and jelly, and so forth, between meals.

Parents should from the first entirely set their face against "pieces" between meals. They prevent a healthy appetite at the proper meal-time, and derange the digestion besides. As a rule, also, sweetmeats are given very indiscriminately. An occasional sweetmeat is not hurtful, if only one be given occasionally. Those made entirely of pure sugar, or a gum pastille, or a small piece of chocolate may be given, *but only occasionally*. Any containing almonds, nuts, &c., should be avoided. Similarly, cakes with raisins, currants, &c., should not be given. Plain sponge-cakes or plain biscuits alone are admissible, but ought to be used at meal times as an addition to the meal, and not between meals.

Finally, children should be taught to take their food slowly and to chew it thoroughly.

The only **beverages** for children are milk and water. The practice of giving small quantities of wine, malt liquors, or stimulants of any sort for little ailments is hurtful in the extreme; still more is the habit of giving these things as a matter of course a most pernicious one. Stimulants should be given to children only on the direct order of the medical attendant, and then only in the small doses he orders, which should be carefully measured. As regards tea, many parents like their children beside them at table, for one meal at least, when they reach two or three years of age, and tea is often the meal. The child may have its cup of warm milk and water sweetened, and if it be barely coloured with tea no harm is done, but it ought not to be more than barely coloured. Thin cocoa, made mainly with milk, is, however, quite digestible for children, and also nourishing.

DIET OF CHILDREN OF THREE YEARS AND UPWARDS.

Within the writer's own experience the diet of children has undergone gradual amplification. He has behind him an experience of well-nigh thirty years, during which he has had the medical supervision of a very large number of children.

In that period the social condition of the people has undergone great changes, and the standard of living has, in every class of life, materially altered. The variety of foods now readily at the command of even the poorer classes of the community has greatly increased, and accessories once deemed luxuries have become common additions to every meal. Thus, in Scotland, porridge and milk used to be the sole article for breakfast; now, if not entirely displaced by tea, it is commonly only the beginning of the meal, and a prelude to the tea, fish, egg, or bacon and egg, with bread and butter, without which breakfast is no meal at all. In the same way, whereas a soup rich in vegetable or broth, with potato or bread, was counted a sufficient dinner for even an adult, now the soup is merely the preliminary to the meat and potatoes, followed by the milk pudding. In consequence most children suffer sooner or later from some form of digestive disorder, at least most of the children who live in towns. It seems to the writer, therefore, desirable to lay down some general rules applicable to the diet of children beyond the years of infancy.

The child of three years of age, if brought up on lines similar to those indicated in the preceding paragraphs, will be getting three or four meals a day, viz.:—

Breakfast of porridge and milk; or bread and milk.

Mid-day dinner of soup or broth, with bread or potato; or fish or fowl, or meat, with vegetable and potato; or rice and milk, eaten with bread and butter; or milk pudding, with stewed fruit and bread and butter or biscuit; or milk, bread and butter, and an egg.

Afternoon meal of milk, with bread and butter, a little jelly, plain biscuit or plain cake; or milk pudding and milk, with bread and butter or a biscuit.

About bed-time: Milk and a biscuit.

Now this is an entirely suitable diet for any child up to six or seven years of age, certain circumstances being guaranteed. These circumstances are that the child has been trained from the earliest years to having its meals punctually at regular hours, and to sitting down, so to speak, properly, and disposing of the meal in a business-like way, and to having no food of any kind, not even fruit, between meals. Any child who has been trained properly in this way, and who has been taught to chew its food thoroughly, and to behave correctly at the table, as every child can be from quite an early age, will give little or no trouble so long as it is in health. Its appetite will be a healthy one, and it will need neither coaxing nor compulsion to take an adequate meal. The child who needs to be coaxed to take its food, for whom it is deemed necessary to prepare titbits to tempt a precarious appetite, who plays with its food, who dislikes so many things that it is difficult to find what it likes, is either in ill-health or has been spoilt; probably it is in ill-health because it has been spoilt. The child that has been properly reared from its infancy has no troublesome likes or dislikes requiring to be taken into consideration. Under these circumstances the child's appetite is the standard of a sufficient diet, and no other guide is required. No artificial regulations or calculations can take the place of this natural guide to the amount of food a child needs.

This fact has been scientifically placed beyond controversy by Professor Chittenden of Yale, and has been shown by him to be applicable to adults of every class of life and character of work. He has shown that a man in health, who will eat slowly and stop as soon as he is satisfied, can be reckoned on to take that amount of material he needs for the purposes of nutrition, and will be found to take from day to day or week to week an amount of food that in nutritive contents varies singularly little. So, in the properly-managed child, its unsophisticated natural appetite is a guide to the amount of food it needs which cannot be improved upon. It is quite a common thing to see a father or mother, who is serving the portions for dinner, carefully estimate the amount of meat, fowl, &c., each child should have, but later to permit the child to have pudding more or less up to the limit of its own desire. This is exactly the opposite of what ought to be. Suppose that the meal is meat, with potato and vegetable, followed by pudding or a sweet of some kind, then the child should be taught to make its meal of the meat, vegetable, and potato, and should be permitted to have as much as it wants, the condition already stated being observed that it eats slowly. Thereafter a small portion of the sweet, regulated by the parent, may be given merely as an extra, but of such inconsiderable amount and of so simple a character that it barely counts as contributing much to the meal, though it pleasantly completes the meal to the child.

If these considerations are properly appreciated, it will be obvious how unwise it is to set several courses before children at dinner or any meal. It is only possible for a man, who has his tastes well under control, from a variety of courses to select just so much of this, so much more of a second, so much less of a third, and so on, to make up a total of a meal that does not err on the side of excess; and there are, comparatively speaking, few men indeed who will not so err. If adults behave so, what can one expect of the child?

The only right principle, then, on which to proceed is to set before the child one course out of which its meal is to be made, and of which, provided it eats slowly, it is to be permitted to have as much as it wishes. If a second course is provided, it ought to be, so far as labour to the digestive organs is concerned, of a trifling character, and it should be restricted in amount. Such a course might well be made to subserve such purposes as assisting the movement of the bowels, and therefore stewed, preserved, or uncooked fruits are most suitable.

On such principles, then, there should be no difficulty in the diet of the child who has been properly reared from its infancy.

The diet stated on the preceding page as suitable for the child of three is, in the main, suitable for the child of four, five, six, or seven. In the later of these years the chief difference will be that fish or fowl or meat, in one form or another, will more frequently form part of the dinner than in the earlier years, and if at six or seven years a second course is given at dinner, it should be a restricted one of fruit in some form.

An entirely undesirable mixture, however, is that of a soup or broth, rich in vegetables, with a subsequent meat course. It cannot be too frequently insisted on that, when soup or broth is given, it should constitute, with bread or potato, the whole meal.

On such lines the child should be dieted till the time comes for it to go to school.

If we assume the child goes to a day-school, returning home about mid-day, in the early years, then no change is required in the diet scheme already set forth. For the child gets the chief meal of the day on its return from school, and there is no reason for any change.

But when, later, the child spends more of the day at school, and gets only an interval of about an hour somewhere between 12 and 2, returning to school till 4 in the afternoon or later, then some change of plan is necessary.

It is quite common, if not indeed the general custom, for the child to hurry home during the interval, have dinner, and hurry back to school. As a rule, also, this is the chief interval of the day, and the only time during school hours the child has for outside games. If the child's home is any distance from school, much of the time may be taken up going and returning, and play is not got; if the home is near, the child grudges every minute spent at the table, and the chief meal of the day is got over as quickly as possible. The worst possible manner of eating and manners at table are thus encouraged, which lay the foundation of digestive trouble and other evils in the future. If there are several members of the family, the school interval is seldom the same for all, and the dinner is thus a meal that comes to be spread over two or three hours, as one child after another comes rushing in, anxious to be served and to rush off again. Dinner ceases to be what it ought to be, a meal to which all the family sit down in comfort and quietness to spend a sociable and helpful time together. Parents who do not strive to keep this meal of the day as the family gathering of the day do not realize the moral influence that is lost to the family life.

But from the purely health point of view there are two serious objections to the mid-day meal in the circumstances noted. One of these is that if part of the interval is used for play, digestion must be seriously disturbed. Energetic physical exercise cannot be properly indulged in immediately after a full meal. The other objection is that no child is fit to engage in active mental work just after a full meal. The full dinner, then, is inimical alike to active games and to intellectual work, or, to put it the other way about, active games or active intellectual work are incompatible with the digestion of a full meal.

This is a conclusion, not only theoretically sound, but one which experience has forced upon the writer's notice. There is a singularly wide prevalence of digestive disorders among children, a rapidly growing prevalence, and the writer attributes it to the circumstances just considered.

For children, therefore, who are occupied at school till late afternoon, dinner should be provided only after school is over. The children can then be trained to tidy themselves properly, to sit down in cleanliness and comfort, to eat slowly, and to cultivate the graces of decent table manners, which so many children, even of the well-to-do classes, conspicuously lack.

Now when children have reached the age when they spend most of the day at school, there is no reason, on the ground of age, in the writer's opinion, against them having a substantial evening meal; no reason, that is to say, why dinner should not be transferred to six, half-past six, or even, if there is reason for it, seven o'clock. The probability is that, in most families, such an arrangement would permit of the parents, and any older members of the family who may have passed out of school, sitting all down together.

In such circumstances the children's meals would be—breakfast, from 8 to 8.30 a.m.; a light lunch, from 12 noon to 1 p.m.; a second light meal, about 4 p.m.; and dinner, from 6.30 to 7 p.m.

Breakfast would consist of porridge and milk, which is a perfectly substantial and nourishing meal without any addition, or bread and milk, or bread and butter and milk, with the addition of an egg or a little fish.

The Mid-day Meal would consist of soup made with plenty of vegetables with toast, or broth with toast, or milk (hot in winter, cold in summer) with bread and butter. An apple or orange could not be objected to, pear or banana.

The Afternoon Meal might be a tumbler of milk and half a slice of bread and butter, or a plain bun, or cookie, or home-baked scone, or a couple of biscuits, or plain sponge-cake.

Dinner would also be a simple meal, consisting of, at the most, a little fish or fowl, or meat with potato and one other vegetable, and a little stewed or preserved fruit. But it is an arrangement equally applicable to the simpler chop and potato, or the even humbler potato and herring.

The question at issue between a mid-day and an evening meal is not the number of courses or the quality of cooking, it is the suitability of the hour in relation to work or play; and that the chief meal of the day should be snatched and bolted, whether by adults or children, in a few minutes stolen from the midst of effort, whether physical or intellectual, muscular or mental, is ridiculous in the extreme.

The arrangement suggested permits of one thoroughly nutritious meal at the commencement of the day, when the digestive organs are fresh, and another when the main work of the day is over, and there is leisure both to enjoy and to digest it, while the smaller meals between are sufficient to maintain the nourishment of the bodily machine while it is hard at work, without withdrawing for digestive purposes energy needed in the muscles or the brain.

TEETHING.

The first set of teeth are called the **milk-teeth.** They have usually all appeared above the gum by the end of the second year of life, or from that to the thirtieth month. The full set consists of twenty teeth, ten in each jaw. The ten are formed of four central **incisors**, or **cutting teeth**, one **canine** or eye tooth at each side of these four, and two **molar** or **grinding teeth** at the back on each side. They appear on an average at the following periods:—

Two central cutting teeth, ...	7th month
Two side, ,, ,, ...	9th ,,
First back tooth, ...	12th ,,
Eye-teeth, ...	18th ,,
Second back teeth, ...	24th ,,

The first teeth of the lower jaw appear earlier than those of the upper jaw. While the above table gives the average dates, the period varies greatly. Thus the central teeth of the lower jaw may appear as early as the third month, and an interval of some months may then elapse before others are cut. There are cases on record of children being born with some teeth already cut. On the other hand, in some cases the teeth are unusually late of appearing, some remarkable cases being on record of children who cut no teeth till some years after birth. As a rule, if the cutting of the teeth is long delayed, it is an indication of some backwardness of development. It may be due to the child not getting food of a proper quality to supply the needed material for tooth formation, and the slowness of the growth of the teeth may coincide with slowness and softness of bone formation. Parents in such cases should consider whether the child is receiving a sufficiently nourishing diet, and especially should be assured that the diet is not too exclusively of a starchy kind, too much corn-flour, rice, arrow-root, or kindred food, and too little milk, and whether some addition of oat flour, broth, meat, eggs, &c., should not be made to its diet.

The teeth are already in their sockets in the jaw when the child is born. It is their continuing growth that causes them to press upwards on the gum till they cut through it. While the milk-teeth are pushing their way upwards the foundations of the permanent set are already being laid in the jaws, and when, at the age of two years or two and a half years, all the milk-teeth are visible, considerable advances have been made in the development of the second set. It is the continued upward growth of the teeth of the permanent set which causes them to press on the roots of those of the milk set. This pressure gradually causes wasting of the roots of the milk-teeth, till, at six years of age, when the first of the permanent set appears above the gum (see pp. 195 and 196), little of some of the milk-teeth is left but the crown attached to the gum, and it usually drops out as the permanent one pushes up to take its place. But at this time, six years of age, the child has not only the twenty milk-teeth, but more deeply in the jaw it has also, already well-developed, twenty-eight of the thirty-two that form the permanent set. At this time, therefore, the child has no less than forty-eight teeth in its jaws.

The period of teething is the time when the advancing teeth are pushing up vigorously under the gum, and when the gum is rendered sensitive and painful by the pressure. The pressure is also irritating to other parts, and the excitement carried to the salivary glands (p. 196) by nervous communication causes the constant flow of saliva. The period of teething is, consequently, a time when the child is more than usually irritable and excitable, and more than usually liable to disturbance of various kinds. While this is so, it is too common to blame teething for all sorts of ailments that have little connection with it, and consequently to neglect attending to some of them, or seeking advice for them, in the hope that when the teeth are cut the ailment will pass away. It is the writer's constant experience that, if the mother or nurse will give a little more than ordinary care to the tending and management of the child, and will watch the condition of the bowels, giving, when it seems necessary, a small amount of gently opening medicine, castor-oil or magnesia, and plenty of careful exercise and fresh air, the troubles of teething will cease to alarm and annoy. The various ailments apt to arise during teething, and the method of dealing with them, are considered further on in the next section. During the period, the child is much comforted, and the process of cutting aided, by having a clean india-rubber ring to press and chew with its gums. As a rule lancing the gums is to be avoided.

For the preservation of the permanent teeth children should be trained to use a tooth-brush with warm water daily, using also, if need be, a tooth-powder of a fine kind. In order to get the child trained to this habit, it is well to teach it to use a brush, even for the milk teeth. A child of two years and a half is quite capable of being trained to a cleanly habit of this sort, and looks upon it as an amusement rather than as an irksome task.

BATHING, CLOTHING, AND EXERCISE.

Bathing.—The directions already given about bathing infants should be carried out with older children. At about six months of age, sluicing with water, which is just tepid, with the morning bath may be given. That is to say, the bath-tub may be filled with water of a moderate warmth, but the child is rapidly sponged with water less warm. Thereafter the drying should be thorough and accompanied by gentle but firm rubbing. If the child seems to feel the cold too much, the colder water should be abandoned for a time. When children become old enough to stand in the bath for the morning cleansing, the water in which they stand should be warm, and tepid water used with a sponge. Children who are able to stand and run about should not be allowed to scamper over the nursery while the bath is being prepared. The body becomes chilled in this way and is unable to stand the cold bath well. The child should be rapidly bathed just out of bed, while it is still in full warmth, able to bear the cold and to induce reaction afterwards. At the same time, if it has been unduly warm and sweating in bed, time must be given for it to cool down in bed before being taken to the bath. After bathing, the children should be quickly dressed before a fire and then allowed to run about. The evening bath should be always warmer than that of the morning, and from it the child should be put straight to bed. If the practice of the morning cool bath is kept up, then as the child grows it will be so accustomed to it that it will be desired and continued.

Clothing. — Regarding clothing sufficient has been said on p. 569, as it is applicable to older as well as to younger children. The dress should fit well, though easily, round the neck, and should always have sleeves to cover the arms. Colds and chest complaints are too frequently due to the half-naked way in which mothers like to see their children's shoulders and arms. If socks are worn, gaiters should be added to protect the legs. When stockings are used, they should never be secured by garters at the knee, for these restrict the circulation and are hurtful; suspenders are the proper means of keeping them up. The same is true of gaiters. Shoes should be as soft and pliable as possible. Specially while in the house should stiff shoes and boots be removed. They prevent free growth of the muscles of the feet and hinder vigorous and elastic movements.

Exercise.—Up to the age of nine months or thereby a child's exercise is obtained mostly in its nurse's arms, or lying kicking in her lap or in its cot. About nine or ten months, however, the child begins to attempt crawling. If the floor be covered by a warm rug or carpet this is well, but care should be taken that draughts do not sweep across the floor. From crawling it will take to getting on its feet by the aid of a chair, and so on till it essays to walk. A mother should let her child go through all the stages at its own sweet will. It will gradually learn itself to use its legs, will become slowly accustomed to maintain the erect position, and thus the muscles are gradually trained to their full use. This is better than setting a child up on its legs and trying to force it into erect ways of moving. If a child is more than usually heavy, its own weight may be too great for the still soft and yielding bones to bear, and the child is often disinclined to attempt standing up straight. It prefers crawling, and it is right, and ought to be allowed to choose its own way.

When children are old enough to walk out and themselves take exercise in the open air, it is best, if there is an open space for it, to let them do so by engaging in some simple game, rather than by dawdling along holding on by the skirts of a nurse. It is free active exercise of arms as well as legs, and of chest muscles too, that a child needs.

During some part of the middle portion of the day the child should have a mid-day sleep, even when it has reached the third or fourth year. In summer the warmest part of the day is best for this purpose, and the room should be cool and darkened, the child being lightly covered. The time of exercise would thus be in the morning, before the heat becomes great, or in the afternoon, but before it becomes too cool in the evening. In winter the time of the daily sleep needs some alteration to permit the child being out while it is warmest and sunniest.

CHILDREN'S APARTMENTS.

In houses where the accommodation is sufficient it is well to have a day and a night nursery. Both should be of a moderate size, cheerful and airy, fitted with a fireplace protected by a guard so efficient that the child can neither crawl through between its bars nor over its top. The ventilation should be well attended to, and should be secured either by a valve ventilator near the roof, communicating with the chimney, or by one of the *topmost* panes of the window being perforated, the openings being capable of partial closure. Heated air always rises, and thus impure air, warm from the lungs, rises towards the ceiling and should be allowed a way of escape as high as possible. The arrangement should be such as to avoid draughts. One good method is to raise the lower sash of the windows by a 3-inch board fixed to the sill and on which the sash rests. A space is thus left between the lower and upper sash through which fresh air enters, but it is directed upwards. If possible, the room should not be next door to a bath-room or water-closet; and it should not be in a sunk flat. The windows should be guarded by rods. The rooms should be heated by fires, and not by hot-air pipes or gas-stoves; the communication between the grate and the chimney should never be closed. It ensures ventilation of some kind when open. As soon as the children leave the night nursery in the morning, the windows should be thrown open to let the room be well ventilated; and similarly, whenever the opportunity exists by the room being empty, the day nursery should be aired. Further, a nursery should be kept scrupulously clean; all discharges should be quickly removed, as well as dirty linen. No cooking should be done in it, and drying of clothes before the fire should be forbidden. In houses where the accommodation is not sufficient to allow of even one room being used as a nursery, the benefit of the children should be considered, and the principles indicated carried out as far as possible in the other apartments.

RATE OF GROWTH OF CHILDREN.

PERIOD AND RATE OF GROWTH IN CHILDREN.

In the previous pages the management of children from birth up to a few years of age has been entered into in some detail. It is not necessary to follow up that section with one considering the management of children from the earlier years to the age of manhood or womanhood. The lines on which such management should proceed are practically similar in both instances. For details regarding food, clothing, exercise, &c., reference can be made to the part of the work devoted to Hygiene, from which full information can be gleaned. Investigations undertaken in recent years, however, have shown that parents and guardians of children have always at hand a simple and reliable means of informing themselves of the general state of physical health and growth of the children under their care, a means of assuring themselves that their method of watching over the bodily well-being of the children is attaining its purpose. This means consists in observing accurately, from time to time, the growth of the children in height and weight.

A large number of statistics show, that up to the age of about 22 years in boys and 18 in girls an uninterrupted increase in height occurs in a state of health, accompanied by a regular increase in weight. The rate of increase varies with the year of life, and, indeed, also with the season of the year. Moreover, a multitude of observations has shown that for each year of life there are a certain height and weight and a certain rate of increase which can be set down as the standard for that year. Diseased conditions, whether apparent or not, seriously affect this normal increase. Any wide departure from the general rule, if not actually in every case indicative of disturbance, becomes at least a signal of possible danger and a warning of the need of careful inquiry into the state of health. Here, then, is a valuable means, ready to the hands of parents and all who are in charge of children, of assuring themselves from time to time of the general health of their children and of the results of their management of them.

For the proper carrying out of the method a register requires to be kept. The name of the child is entered, and opposite each observation the date should be written. At regular periods, say at intervals of one month, the height and weight should be measured and duly noted. The height is measured from the sole of the foot to the crown of the head; shoes are therefore, removed. The weight ought not to include clothes; and as the amount of clothing varies at different times, it is well to take the weight with clothes and shoes, and then weigh these separately, deducting their amount from the total. Besides the height and weight the measurement round the chest is valuable. It should be taken next the skin—without clothing, that is to say. The measuring-tape is placed quite horizontally round the chest. The lower edge in front touches the upper part of the nipple and includes the lower part of the shoulder-blades behind. To ensure that the chest is always expanded with air to the same extent, the person is made to count from one to ten, when the measurement is taken. The arms should, at the time, hang loosely by the sides.

The Value of such Periodical Measurements is shown by a variety of circumstances. Dr. Percy Boulton gives one instance that occurred at the Boys' Home, Regent's Park: "In 1875 it was found at that institution that the boys had not increased on an average 2 inches a year, so, in January, 1876, a revised dietary was used, and it was found after one year that, by this simple change, the average increase amongst the boys had been over 2 inches in stature and 6¼ pounds in weight." In prisons and lunatic asylums the inmates are weighed once a month, and the information given by the scales is taken as an indication of the sufficiency of the diet in quantity and quality. But the information is of further value. If the weight is not satisfactory, and no error in diet accounts for this state of affairs, an examination of the person is made. As a result maladies are discovered in an early stage, before other signs had made themselves manifest; and thus disease is detected at an early stage, when it may be more easily and successfully treated. It has been shown that loss of weight is one of the earliest occurrences in consumption, and may be detected before cough has begun.

Everyone knows that young people who are growing rapidly are, as a rule, more easily fatigued and can stand less bodily and mental strain than others. If regular measurements were taken and showed that a rapid increase in height was taking place, unaccompanied by a corresponding increase in weight, it would be a sufficient warning of the necessity of care and avoidance of undue exertion both bodily and mental. A boy or girl who exhibits rapid bodily growth, cannot be expected to exhibit the same mental activity as one whose energies are not so much diverted in one direction. Allowance ought, therefore, to be made in the former case for less progress in education and less inclination for school work. In such a case parents and guardians ought to refrain from endeavouring unduly to push school work, and ought rather to encourage open-air amusements and exercise. The reverse condition of unusual cleverness and devotion to books and school work, accompanied by diminished growth in height and weight, would be equally taken note of as undesirable, and instead of the mental application being applauded and encouraged it would be restrained until the verdict of the measuring rod and the scales was more favourable.

It has been very strongly urged by those who have devoted special attention to the functions of the brain and nervous diseases that such methods of regular measurement ought to be systematically employed by schoolmasters and all who have to do with the regulation of the education of children, and that physical growth rather than age ought to be the indication of the stage of progress in education. Such observations would show that mental dulness was often healthy, and would aid in distinguishing between pupils who were backward because of bodily conditions and those who were backward because of idleness and carelessness. They would also show that brilliance at school was often unhealthy and undesirable, and in need of careful restraint rather than encouragement.

STANDARDS OF GROWTH.

In order to obtain any benefit from the weighing and measuring of children, one must know what ought to be the height and weight of the child at particular ages, so that the ascertained height and weight may be compared with that which is taken as the standard in health. This standard has within recent years been supplied by very numerous observations made upon children and grown-up persons at various ages. Tables constructed on the basis of these observations will be given. The tables given are derived from Dr. Roberts' *Manual of Anthropometry.* At the top of each column of the table is noted the year of life, and below are given the mean height, the mean growth occurring from one year to the next, the mean weight and its mean growth from year to year. It is necessary to explain that mean height, mean weight, &c., imply the height, weight, &c., which were found to be the most common among the multitudes examined.

TABLE I.

SHOWING THE MEAN HEIGHT, MEAN WEIGHT, THEIR ANNUAL RATE OF GROWTH, AND THE MEAN CHEST-GIRTH, WITH ITS ANNUAL INCREASE, OF 13,931 BOYS AND MEN BETWEEN THE AGES OF 4 AND 22 YEARS, OF THE POPULATION IN LARGE ENGLISH TOWNS—ARTISAN CLASS.

AGE LAST BIRTHDAY.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21 to 22
Mean Height (in inches), ..	38·5	41·0	43·0	45·0	47·0	49·0	50·5	51·5	53·0	**55·5**	**58·0**	**60·5**	**63·0**	64·5	65·5	66·0	66·25	66·5
Mean Increase in Height, ..	—	2·0	2·5	2·0	2·0	2·0	1·5	1·0	1·5	**2·5**	**2·5**	**2·5**	**2·5**	1·5	1·0	0·5	0·25	0·25
Mean Weight (in pounds), ..	44·0	50·0	54·0	57·0	59·0	62·0	66·0	70·0	74·0	**78·0**	**84·0**	**94·0**	**106·0**	116·0	122·0	128·0	132·0	136·0
Mean Increase in Weight, ..	—	6·0	4·0	3·0	2·0	3·0	4·0	4·0	4·0	**4·0**	**6·0**	**10·0**	**12·0**	10·0	6·0	6·0	4·0	4·0
Mean Chest-girth (in inches), ..	—	21·0	21·5	22·0	22·5	23·0	23·5	24·0	24·5	25·0	26·0	27·0	28·5	29·5	30·0	30·5	31·0	31·5
Mean Increase in Chest-girth, ..	—	—	0·5	0·5	0·5	0·5	0·5	0·5	0·5	0·5	1·0	1·0	1·5	1·0	0·5	0·5	0·5	0·5

Note.—The height is taken without shoes, but the weight included clothes (which are taken to equal 7 to 10 lbs.).

TABLE II.

Showing the Mean Height, Mean Weight, and their Annual Rate of Growth of 10,904 Girls between the Ages of 5 and 18 Years, attending the Public Schools of Boston, U.S.A. (Bowditch).

Age last Birthday.	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mean Height (in inches), ...	41·0	43·5	45·5	47·5	49·5	51·5	**53·5**	**56·0**	**58·0**	**60·0**	61·0	61·5	62·20	62·0
Mean Increase in Height, ...	—	2·5	2·0	2·0	2·0	2·0	**2·0**	**2·5**	**2·0**	**2·0**	1·0	0·5	0·5	—
Mean Weight (in pounds) including clothes, ...	40·0	44·0	48·0	52·0	56·0	60·0	**66·0**	**76·0**	**88·0**	**96·0**	104·0	110·0	112·0	114·0
Mean Increase in Weight, ...	—	4·0	4·0	4·0	4·0	4·0	**6·0**	**10·0**	**12·0**	**8·0**	8·0	6·0	2·0	2·0

Table II. is derived from Dr. H. P. Bowditch, and the girls were partly of American, Irish, and mixed English, Irish, and American parentage.

It is necessary to notice the difference between the physical conditions of the boys and men of Table I. and the girls of Table II., else erroneous conclusions would be drawn. The boys of Table I. belong to the artisan class, living in large English towns. They are, therefore, not in circumstances best fitted for natural and unimpeded growth. They are statistics of boys subject to the more or less constant influence of at least not quite healthy surroundings, bad air, not too abundant nourishment, and labour begun in early youth, just at the period when growth ought to be most rapid. The girls of Table II., on the other hand, belong to a more favoured class, at least including many of the more favoured classes, likely, therefore, to show statistics of better stature and weight.

In order to show the differences in growth due to more favourable physical conditions of life, Table III. is given, dealing with boys and men of the most favoured classes, as found in English public schools, in the army, navy, universities, and medical schools. Thus Tables I. and III. will afford standards for boys and men, whether belonging to the artisan or more favoured classes, and Table II. will afford a standard for girls. Tables II. and III. will also permit a more reliable comparison to be drawn between the growth of girls and that of boys.

TABLE III.

Showing Mean Height, Mean Weight, Mean Chest-girth, and Mean Annual Growth of 7709 Boys and Men, between the ages of 10 and 23 Years, belonging to the most Favoured Classes of the English Population (Roberts).

Age last Birthday.	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mean Height (in inches),	53·0	54·5	56·5	58·5	**61·0**	**63·5**	**66·5**	**68·0**	68·5	68·75	69·0	69·0	69·0	69·0
Mean Increase in Height,	—	1·5	2·0	2·0	**2·5**	**2·5**	**3·0**	**1·5**	0·5	0·25	0·25	—	—	—
Mean Weight (in pounds) including clothes=9 pounds,	67·0	73·0	80·0	88·0	**98·0**	**110·0**	**126·0**	**140·0**	146·0	148·0	150·0	152·0	—	—
Mean Increase in Weight, ...	—	6·0	7·0	8·0	**10·0**	**12·0**	**16·0**	**14·0**	6·0	2·0	2·0	2·0	—	—
Mean Chest-girth (in inches), ...	—	—	27·5	28·5	29·5	31·0	33·0	34·0	34·5	34·75	35·0	35·25	35·5	35·75
Mean Increase in Chest-girth, ...	—	—	—	1·0	1·0	1·5	2·0	1·0	0·5	0·25	0·25	0·25	0·25	0·25

Comparison between Growth of Boys and Girls, and between Growth of Boys of Different Classes. Comparing first of all Table I. with Table III., it is evident that the boys and men represented in the latter are in a better physical condition than those of the artisan class. At the age of 21 the most favoured class has a mean height of 2½ inches greater than the artisan class. The tables afford no means of comparison below the age of 10 years, but at that age the most favoured class has still the advantage of 2½ inches. At the age of 16 the difference in height between the two classes is as much as 3½ inches, due to the very rapid rate of growth about that age among the favoured classes, among whom it is greatly reduced in the 18th year, while in the artisan class the greater rapidity of growth does not begin so soon, does not go on so quickly, but lasts a year longer, so that the great difference in height at the age of 18 becomes reduced during the succeeding year. These differences are undoubtedly due to the less fortunate circumstances of the artisan class, which not only diminish the rate of growth but actually lessen its total amount. Similar differences are exhibited in respect of weight and chest-girth. At 21 years of age the artisan is a mean of 16 pounds lighter than his more favoured neighbour. At 10 years of age the difference is only 1 pound, but it is gradually and steadily increased, and the most favoured class have a permanent advantage of some 14 pounds in weight. In chest-girth at 21 the artisan is nearly 4 inches less than the youth of the non-labouring class.

A perfectly accurate comparison between the growth of girls and boys is not obtainable from the tables, for the girls belonging to Table II. were not drawn exclusively from one class. But the table shows that girls attain their full height earlier than boys by between two and three years, namely at 17 years, and that their mean height is from 4 to 7 inches less than men. Even at birth there is a difference in height and weight between male and female children to the advantage of the former. The difference in weight between the two sexes and in chest-girth is also marked. What is specially worthy of note, however, is that it is between the 11th and 13th years that growth is most rapid in girls both in height and weight. After 14 growth, which began to lessen the year before, rapidly diminishes, and is reduced to very little after 16. This rapid falling off in growth is coincident with other changes of great importance discussed in Sect. XXVIII.

In the tables the figures between the years when growth becomes most rapid and then falls off are given in black type for the sake of emphasis.

The Relation of Height to Weight. It is of importance to notice that increase in weight should occur in a regular way with increase in height. The following table is given by Dr. Percy Boulton in the *Lancet* of Oct. 16, 1880, as a reliable working standard. It is deduced from the results of observations of the same children who were examined at least once annually. The children were selected as average children of healthy well-to-do parents, brought up with suitable food and surroundings, giants and dwarfs being excluded.

TABLE IV.

Showing the Relation between Height and Weight (Boulton).

A child of	3 ft.	0 in.	should weigh	2 stones	8 lbs.
,,	3 ,,	1 ,,	,,	2 ,,	10 ,,
,,	3 ,,	2 ,,	,,	2 ,,	12 ,,
,,	3 ,,	3 ,,	,,	3 ,,	0 ,,
,,	3 ,,	4 ,,	,,	3 ,,	2 ,,
,,	3 ,,	5 ,,	,,	3 ,,	4 ,,
,,	3 ,,	6 ,,	,,	3 ,,	6 ,,
,,	3 ,,	7 ,,	,	3 ,,	8 ,,
,,	3 ,,	8 ,,	,,	3 ,,	10 ,,
,,	3 ,,	9 ,,	,,	3 ,,	12 ,,
,,	3 ,,	10 ,,	,,	4 ,,	0 ,,
,,	3 ,,	11 ,,	,,	4 ,,	2 ,,
,,	4 ,,	0 ,,	,,	4 ,,	4 ,,
,,	4 ,,	1 ,,	,,	4 ,,	6½ ,,
,,	4 ,,	2 ,,	,,	4 ,,	9 ,,
,,	4 ,,	3 ,,	,,	4 ,,	11½ ,,
,,	4 ,,	4 ,,	,,	5 ,,	0 ,,
,,	4 ,,	5 ,,	,,	5 ,,	2½ ,,
,,	4 ,,	6 ,,	,,	5 ,,	5 ,,
,,	4 ,,	7 ,,	,,	5 ,,	7½ ,,
,,	4 ,,	8 ,,	,,	5 ,,	10 ,,
,,	4 ,,	9 ,,	,,	5 ,,	12½ ,,
,,	4 ,,	10 ,,	,,	6 ,,	1 ,,
,,	4 ,,	11 ,,	,,	6 ,,	3½ ,,
,,	5 ,,	0 ,,	,,	6 ,,	6 ,,

The general conclusions will best be given in Dr. Boulton's own words. "I find," he says, "that average English children, brought up under favourable circumstances, grow from 2 to 3 inches a year. *A growth of less than 2 inches or over 3 should excite apprehension.* The former would indicate arrested development, and the latter a rate of growth beyond the powers of average children. Rate of growth should be regular, and, being so, prognosticates future stature, because the healthy child that grows 2 inches a year passes 5 feet at about 15, which indicates a short stature (*i.e.* if a male about 5 feet 6 inches, female about 5 feet 1 inch). The healthy child growing 2½ inches a year is 3 feet 2 inches at 3 years, and passes 5 feet at 13 to 14 years. Such child will be a medium-sized adult (*i.e.* if a male about 5 feet 8 inches, female about 5 feet 3 inches). The quick-growing healthy child that accomplishes 3 inches a year passes 5 feet at 10 or 11, and eventually makes a tall adult (*i.e.* if a male about 5 feet 10 inches, female about 5 feet 5 inches). . . . Of course one meets with many variations, but these variations are, I believe, always abnormal. Some children seem to do their growing by fits and starts, the common diseases of children arresting, for the time, their progress, which is made up for afterwards by a supreme effort. Such growth is unnatural and often very detrimental. I believe, then, that every healthy child has its own regular rate of growth of 2, 2½, or 3 inches a year, from which it has no right to vary more than ¼ inch a year."

"Next as to weight for height, whether a child grows 2, 2½, or 3 inches a year, weight for height should be, in each case, identically the same; and all children should grow broad in proportion to their height. *Between* 3 *and* 4 *feet the increase in weight should, I find, be* 2 *pounds per inch, and between* 4 *and* 5 *feet* 2½ *pounds per inch.*" . . .

"Some children exceed these weights (those given in Table IV.) that are by no means giants, and really healthy, well-nourished children of healthy parents and favourable surroundings generally attain these averages. But what of children that fall below the standard? I find that there is a 7-pound margin of safety, and that children falling more than 7 pounds below this standard are devoid of reserve capital on which to draw, and, consequently, they succumb quickly to many constitutional diseases. This, therefore, may be called the preventive-medicine margin, beyond which lies the dangerous land of cachexia" (a depraved condition of body).

"Arrest of growth or loss of weight precedes so many diseases that it may be looked upon as a danger signal; and, if the caution is noticed before the disease point is reached, catastrophe may frequently be prevented."

These tables are given as standards for reference, and brief suggestions will be given in closing this section as to their method of use.

Each child should be weighed and its height taken once a month, or at least once a quarter. Reference should then be made to Table I. or III. in the case of boys, according to the class to which the child belongs, the labouring or more favoured class, or to Table II. in the case of girls. It will thus be seen whether the child reaches the standard for its age. The column of the table is taken headed with the age of the child at its last birthday; and in that column will be found the height, weight, and chest-girth to which it should reach. The results of each weighing and measuring should be noted in a book kept for the purpose, the date being accurately entered. The increase that has taken place since the last trial should be noted and compared with the standard in the tables. Lastly, the height of the child should be referred to Table IV., and it should be noticed whether the weight reaches to that mentioned in the table as proper to the particular height.

Of course there will be variations. Any considerable variation, however, and specially any sudden variation, should lead to careful consideration of all the child's circumstances, its food, the fresh air and exercise obtainable by it, the amount of school and other work, &c. Some change in these may at once be suggested. If no such circumstance seems to account for the departure from the rule, medical advice should be sought.

Especially between the ages of 11 and 17 should the results of the weighing-chair and measuring-rod be carefully watched. They will throw light on the question of over-pressure at school, and, if their warning is accepted, will do much to prevent it. Every school ought to have a room set apart and equipped for the weighing and measuring of the pupils. The standards of weight and height should be painted on the walls, and each pupil's height, weight, and chest-girth should be registered at regular periods. Education would then have a better chance of being conducted on physiological principles, and with some regard to the physical development of the pupils.

SECTION XXVII.

THE MANAGEMENT OF CHILDREN IN DISEASE

General Signs of Disease in Children:

General Treatment of Children in Disease:

Affections of the Newly-born Child:

Irregularities of Form—Tumours of head and back—Hare-lip and Cleft-palate—Blue Disease—Tongue-tie—Cataract—Congenital Dislocation at the Hip—Congenital absence of Bile-ducts—Congenital Obstruction of Stomach Outlet;

Diseases of Navel and Eyes; Jaundice of the Newly-born; Retention of Urine and Stools; Undescended Testicle;

Swelling of the Breasts.

Diseases Common to Childhood:

Ailments at the Periods of Teething and Weaning;

Coughs, Colds, and Affections of the Chest—Cold—Bronchitis—Cough—Pneumonia—Broncho-pneumonia;

Affections of the Nose, Throat, and Ears—Obstruction of the Nostrils—Discharge from the Nose—Hypertrophy of the Lining Membrane of the Nose—Inflammation and Hypertrophy of Tonsils—Discharge from the Ear—Earache—Foreign Bodies in Nose or Ear;

Affections of the Mouth, Stomach, Bowels, &c.—Thrush (Sprue)—Inflammation and ulcers of the mouth—Vomiting—Colic—Looseness of bowels—Infantile cholera—Intussusception—Costiveness—Worms—Falling of the bowel—Rupture—Bed-wetting;

Spasmodic Diseases—Convulsions—Night-terrors—Child-crowing—Water-in-the-head, &c.;

Fevers;

Skin Diseases—Tooth-rash—Red-gum—Scald-head—Running ears;

Rickets;

Accidents—Burns, Wounds, Sprains, &c.—Falls on the head—Bleeding at the nose—Choking.

GENERAL SIGNS OF DISEASE IN CHILDREN

Much may be learned as to the state of health of a person by examining the face, eyes, mouth, and various parts of the body; but in dealing with children, who cannot express their feelings, this examination becomes of very great importance. It is possible from it not only to tell whether a child is well or ill, but often also, if ill, what is the character of the ailment and situation of the disease. The information is to be obtained from observing (1) the colour of the skin, face, eyes, lips, (2) the expression of the face and eyes, (3) the state of the mouth and teeth, ears, and throat, (4) the gesture and attitude, (5) the movements of the chest, (6) the movements of the belly, (7) the general state and warmth of the body, (8) the cry of the child, (9) the character of the stools, and (10) the nature of the sleep.

What should be looked for in each of these respects will be briefly indicated.

The Colour of the Skin, Face, Eyes, and Lips.—The transparent rosy tint of the skin of the healthy child may be replaced by a general *yellow* colour, seen not only over the whole skin, but also in the white of the eye, indicating jaundice, *i.e.* some affection of the *liver*. A form of jaundice is not uncommon in newly-born children (see p. 595). The skin may be dusky, the lips being bluish, and the same duskiness showing strongly under the finger and toe nails. This is associated with a peculiar condition of the *heart* (See Blue Disease, p. 593). In affections of the *lungs*, where the breathing is seriously impeded, a similar alteration of colour affects the face and lips. Serious disease of the *stomach or bowels* produces a *dull, sallow, or leaden* hue of the face.

In children, nipping of the bowel, as in intussusception (p. 604), or obstruction by a band of adhesion, is accompanied by *death-like pallor*.

Expression and Features.—The most remarkable and sudden alteration of features is seen in diseases of some part of *the bowel*, where the face is pinched and furrowed, and becomes rapidly emaciated, sunken, and lustreless, and, as noted above, extremely pale. The rapid movements of the nostrils, accompanying laboured breathing, is a sign of *affection of the lungs*. Hacks and fissures about the corners of the mouth, sunken bridge of the nose, and a general withered and old-mannish look are frequent in a disease of the blood called syphilis (p. 546). A large head, with prominent over-arching forehead, and small development of the face, is the well-known characteristic of a chronic form of *brain disorder*—water-in-the-head—(p. 155). In the early stage of this ailment the child is drowsy, dull, and listless, however lively and active it may naturally have been. The eyes should be observed as to the way in which they close, the complete or incomplete way in which the eyelids meet, the presence of squinting; and the pupil should be watched to note whether it responds to light—becoming small rapidly when light is directed on the eyes, and again expanding when the light is withdrawn. A wide and fixed pupil is almost certainly a sign of serious *nervous disturbance.*

Mouth and Teeth.—The points to notice here are the heat and state of moisture of the mouth, the condition of the gums, the number of the teeth cut or near to cutting, the softness or dryness of the tongue, its colour and cleanness.

This examination is made by means of the finger, and the person making the examination ought always to wash the finger thoroughly immediately before introducing it into the child's mouth, as well as immediately afterwards.

In teething, of course, the mouth is hot and perhaps dripping with saliva, and the gums may be swollen, tender, and florid. A white tongue points to disorder about the *stomach.* A brown dry tongue is the state in fever of the typhoid type. The tongue is also frequently covered with patches of a white vegetable growth (Thrush, p. 599). The inside of the lips and cheeks are to be inspected for the presence of small ulcers.

The Ears should always be carefully examined. A boil in the ear is very common in young children, and may occasion days of feverishness, restlessness, and crying, the cause of which remains undiscovered till discharge from the ear reveals it. Gentle pressure with the finger on the part of the cheek that projects over the canal of the ear will provoke evidence of pain, if there is any irritation in the interior.

The Throat must always be examined, the child being held on the lap of one person in front of a well-lighted window, while the observer gets a view of the throat with the help of a spoon-handle to depress the tongue.

Gesture and Attitude.—Note here the movements of the hands and arms. Children, like grown-up people, often try to aid obstructed breathing by grasping with the hands and raising the arms to help expansion of the chest. In severe *fevers* the rigid bend of the fingers with the thumb doubled in on the palm is very noticeable. In irritation of the *bowels* the thighs are bent up on the belly while the pain lasts. The involuntary movements and twitches of *St. Vitus' dance* (p. 182) are well known.

Movements of the Chest.—Rapid and jerky movements, with constriction at the sides, and accompanied by heaving of the belly, and depression at the collar-bones, indicate serious *lung* mischief. Breathing that is accompanied by a pleuritic stitch is manifested by the sudden convulsive stop in the middle of the inspiration, the pain being also shown by the movements of the face and the cry. Disease of the *belly* also affects the movements of the chest, for if movement of the belly causes pain it will be kept quiet, and all the breathing will be performed by chest movements, which will be short and quick, incomplete, that is to say, prevented from going so far as to exert downward pressure on the belly.

Movement of the Belly.—As indicated above, the movements of the belly may be exaggerated, when the disease is in the chest, to relieve the chest of the work it is unable to perform, or the movements of the belly may be entirely restrained when it is itself the seat of disease. In the latter case it will be tense, the muscles firmly contracted to guard against movement, and the thighs will be bent up on it to relieve it of strain. When the belly is the seat of pain, specially colicky pain due to flatulence, the contracted muscles make the belly feel tight and firm, and the child usually kicks and twists itself about, crying lustily while the pain lasts. But as soon as the spasm of pain has passed, the child speedily quiets down, giving vent only to a final sob or two, unless another attack rouses it to the same crying and kicking. On the other hand, if the pain is inflammatory the child lies moving as little as possible, for movement increases this pain, and there is moaning rather than crying out.

The General State and Warmth of the Body may be gathered from noticing the plumpness or wasted appearance, firmness or softness, of the child. The way in which the child holds itself together, also, should be observed, whether bright and buoyant, or languid and drooping. The heat of the body is roughly ascertained by laying the hand on the skin or on the head; but the most reliable means is by using the thermometer (p. 38). It will indicate a rise of temperature amounting to fever when feeling with the hand would give no hint of anything wrong. A mother who learned how to use it, and it is very easy learning its use, would find it of inestimable value. It would not only tell her whether her child was really ill, but also, within an hour or two of the employment of her simple method of treatment, she would be able to tell by means of it whether any good had been done.

The Cry of the child is often peculiar. The

Plate XXXI

APPLIANCES FOR THE NURSERY

The upper part of the plate shows a bed arranged with a bronchitis kettle. From each of the four pillars of the bed the top has been unscrewed to permit a piece of blind roller to be fixed, as a continuation of the pillar.

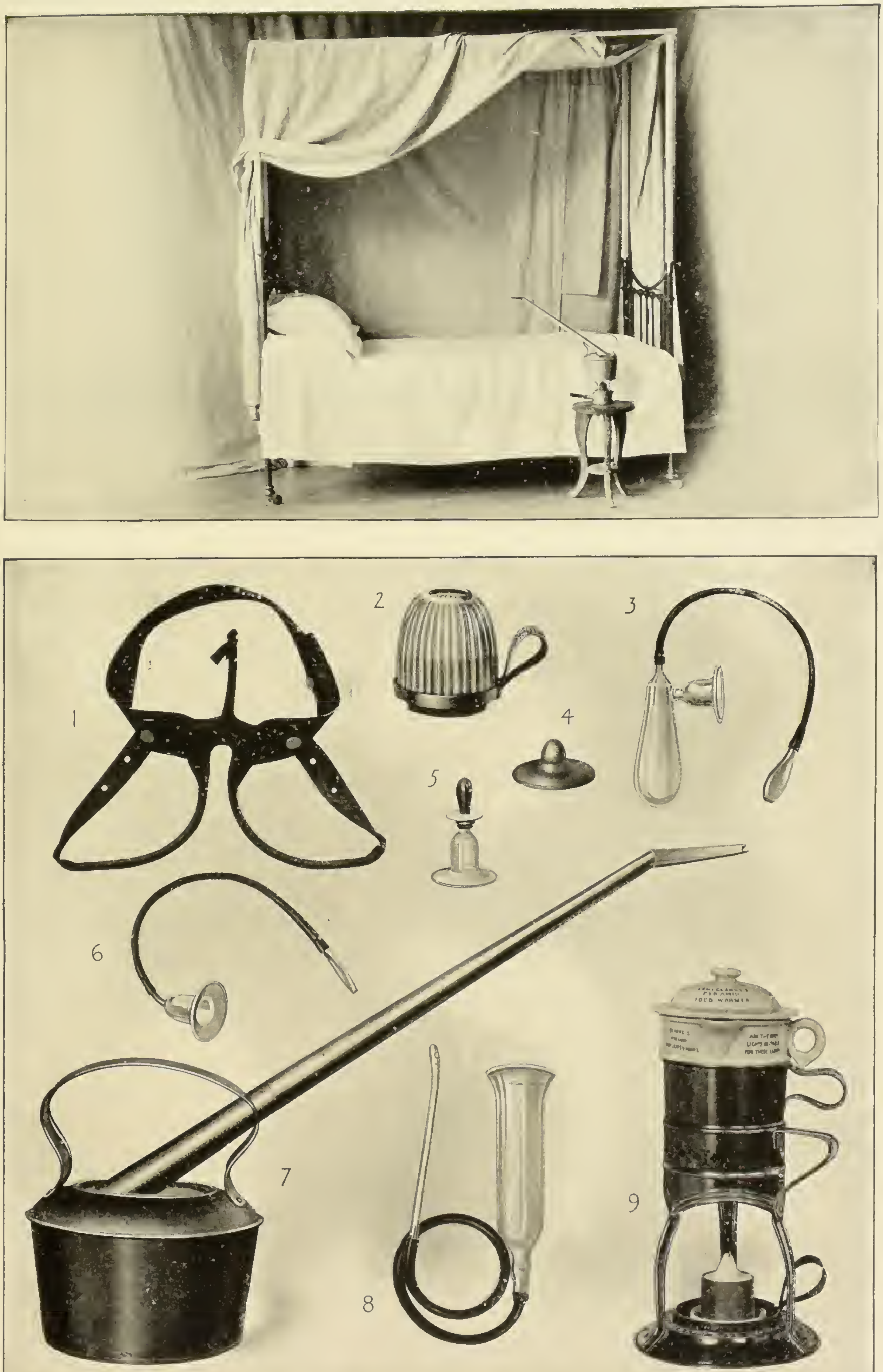
The four pillars thus prolonged are connected by ties of window-blind lath.

Sheets are then thrown over. In the figure the sheets have been turned aside to show the blind roller and lath supports.

The lower part of the plate shows various articles of use in the nursery.

1. A child's double truss for rupture (see p. 606), made entirely of rubber, the upper circular band going round the waist, the lower half-circles being formed by bands which pass in front between the thighs, and come up to be fixed to an ivory button at each side.
2. A night light.
3. A breast-exhauster.
4. A rubber nipple-shield.
5. A glass nipple-shield.
6. A glass nipple-shield with tube and teat, permitting the mother to fix the glass over the nipple and fill it before putting the teat into the child's mouth.
7. A larger view of the bronchitis kettle.
8. A glass cylinder and rubber tube, ending in glass catheter for washing out the bowel or for feeding by the bowel (see vol. ii, p. 14).
9. An arrangement for heating the child's food by night.

PLATE XXXI



APPLIANCES FOR THE NURSERY

feeble, plaintive cry is itself sufficiently suggestive. An acute cry, very shrill and intermittent, is not infrequent in "water-in-the-head" (p. 155), while a hoarse, muffled cry is heard in croup (p. 538). If a child, apparently healthy, takes suddenly to a constant crying, which movement and dandling seem only to aggravate, thorough search should immediately be made to see that it is not due to some wayward pin, or some uncomfortable fastening or knotting of the dress.

The Character of the Stools, &c., give important indications of the state of the health. In the case of the infant they should be two in number daily, lightish yellow in colour, soft, and not offensive in smell. If they are not so frequent as usual, or more frequent, dark or green coloured, too liquid, or curdy and offensive, something is not quite right, which some slight alteration in the diet, in quantity or quality, or both, may set right even without medicine. (Refer to page 572.)

The Sleep of children is disturbed during illness. A restless disturbed sleep, from which the child often starts up with a cry, should always call attention to the child's state of health. It may be only some error in diet that is the cause. If so, this will be indicated by the state of the stools. Perhaps the child has had no motion the previous day. Let inquiry be made, and opening medicine given if necessary. Disturbance in the bowels due to worms is a frequent cause of this restlessness (p. 606). On the other hand, an undue drowsiness, languor, and listlessness are not to be neglected, specially in children between two and seven years of age. These are among the early signs of brain disease.

GENERAL TREATMENT OF CHILDREN IN DISEASE.

When a child is suspected or seen to be unwell there are certain steps that ought to be taken at once, no matter what may be the nature of the illness, steps which, if taken immediately, will, in many cases, be able to convert into a short and slight illness what, if neglected, might become a long and serious one, and which may even be sufficient to arrest the illness altogether.

As soon as the child is supposed to be ill it should be stripped, bathed, and put to bed, if possible in a quiet room, not in a noisy, much-frequented apartment. The bed should be fresh and clean, not closed in, and freed entirely from hangings and curtains. *The room should be well ventilated, but free from draughts.* A fire secures a continuous supply of good air to a considerable extent, besides warming the room, which should be kept as much as possible at a regular temperature—a moderate one (62° Fahrenheit),—which is most easily managed by the aid of a thermometer kept hanging in the room.

At once attention is to be directed to (1) the diet of the child and (2) the state of the bowels. (1) The whole trouble may have arisen from overfeeding or improper feeding. The child is, therefore, to be put on milk diet entirely (see the directions given under MANAGEMENT OF CHILDREN, p. 565). The quantity is to be kept strictly moderate, small quantities given in frequent but regular intervals being better than large quantities at one time. Irregular feeding must be avoided, and no solid food whatever given. (2) If the bowels have not been properly moved for some time a moderate dose of castor-oil or of fluid magnesia, or similar mild purgative, may be given. This is, generally speaking, all that should be done on the mother's or nurse's sole responsibility, when the services of a medical man are at all obtainable. When such services can be obtained they should be at once sent for, as very slight symptoms may be the forerunners of very serious disease. The medical man being in attendance, his advice, *and none other*, should be strictly, promptly, and conscientiously followed.

But it will often happen that medical aid is not within immediate reach; that, owing to distance or some other case, it may be many hours before the doctor can arrive. Meanwhile the child seems highly fevered, is very restless in its sleep, seems to be wandering, or the mother fears convulsions. What is to be done? This, at any rate, must not be done: the mother or nurse must not seek to quiet the child by "soothing syrups" of any description. Especially in nervous conditions is a great deal of harm possible by their means. There are, however, two things the mother may do without the least fear, two things beside what has been already advised. First an injection into the bowel should be given for the purpose of producing at once a full clearing-out of the lower bowel. The fact that castor-oil or some other opening medicine has been already given does not stand in the way of the injection, if it seems needed, for the injection will clear out the lower part of the bowel, while the medicine sweeps everything down from the upper end.

Mode of Injection.—An enema-syringe should be used (as represented on Plate XXXII.). It is an oval elastic bag, with an opening at each end of the oval; from each opening proceeds an elastic tube. One tube ends in a long ivory nozzle for insertion into the bowel. The other end dips into a bowl of water. When the bag is compressed by the hand, anything it contains is forced out through the nozzle; when it is allowed to expand it sucks up a fresh supply of water by the other tube, the movement of the water being directed by valves. Take a small bowl of tepid water, work the syringe for a little time till it is found to be in good working order, expelling a steady stream of water, unmixed with air, from the nozzle with each compression of the bag. Now oil the nozzle, and by a twisting movement gently pass it up into the child's bowel, using no force, and directing the point slightly backwards and to the left, the child lying on its left side in bed or in the nurse's lap. An ivory plate prevents it being pushed too far. Then gently but steadily squeeze the bag till the water has all passed into the bowel; then relax and let it refill; gently press again. *Take care that all the time the other tube—the inlet tube—is dipping below the surface of the water in the bowl, so that no air is sucked in.* Even in the case of quite a young child the quantity injected by two or three compressions of the bag is not too much, when it is desired to act well and quickly. With older children a small bowlful of water may be injected with perfect safety. Instead of water, pure olive-oil, gently warmed, may be injected, from 2 to 5 ounces, that is from less than a half to a whole tea-cupful. When an enema-syringe cannot be obtained, a brass one with ivory point may be used. Glass syringes are rather to be avoided, and, if used, great care must be taken that the point is quite round and not sharp, and that it is not broken in the bowel.

The second thing that may be done for a child threatened with some illness that looks serious is to give it a special warm bath or wrap it in a warm pack.

To give the **Warm Bath** the water should be at a temperature of 98° Fahr., and it is best to test the heat by the thermometer rather than by feeling with the hand. The child should be set in the bath up to the neck, and in the case of an infant, the head should be supported by the hand and arm of the nurse. The child should remain in the bath from ten to twenty minutes, the heat being all the time maintained by frequent additions of warm water round the sides. The child may then be lifted up, rolled in a half-blanket or large bath-towel, and without any drying put into bed. After another hour, or even less if the child finds the blanket too disagreeable to let it rest, the child should be rapidly rubbed down, clothed in a warm flannel gown and carefully wrapped in the bed-clothes. Or the child may at once, on being lifted from the bath, be rubbed down, clothed in flannel, and put to bed.

The Warm Pack.—The child is to be stripped naked and rolled in a half-sheet or half-blanket wrung lightly out of warm water, and laid in bed and covered by the bed-clothes. It should be kept so for an hour and then rubbed down, and its flannel night-gown put on. Young children grow restless by being imprisoned in the wet sheet. They are usually quiet if their arms are allowed out of the sheet.

The benefit of the warm bath is that it brings the blood to the skin, it causes the blood-vessels of the skin to relax. They become able to contain more blood in consequence, and thus deeper parts are relieved of too great a quantity of blood. At the same time, if there is fever, the water used being of a considerably less degree of heat than the blood, heat is withdrawn from the body, and that has a soothing effect on the nervous system. If, as has been advised, an injection has previously been given and has produced free evacuations, the unloading of the bowels will have already acted in a similar way. The blood will have been diverted from the head and central nervous system, and the calming effect of the bath or hot pack will be all the more perceptible because of this previous action.

Now these two methods of treatment of children are simple in the extreme, and if carried out with a moderate degree of intelligence are incapable of doing harm. They will often dispel from the child within a short time all the more alarming symptoms, and secure for it some quiet rest and sleep. Often a child, that late in the evening shows signs of some serious illness, if treated in this way, and if care is given to the diet, &c., as already directed, will appear perfectly well in the morning. Even if not, and even if the illness does go on, the child is in a much more favourable condition in relation to the future course of the illness than it would have been.

AFFECTIONS OF THE NEWLY-BORN CHILD

IRREGULARITIES OF FORM IN THE NEWLY-BORN.

An **irregularly shaped head** is not infrequent as the result of severe labour, or the use of instruments, &c. It is frequently extremely elongated, perhaps badly flattened or pressed in at one side. No fear is to be entertained on this account. Within a few days the head will gradually return to the normal shape.

Tumours or swellings may exist on the back of the head or at other parts of the head. **Spina Bifida** is the name given to a tumour occurring at the lower end of the backbone, due to an arrest of the growth of the bone, and protrusion of the membranes and other parts of the spinal cord in the shape of a bag. It is in many cases amenable to skilled treatment. Such swellings must not be interfered with by the mother or nurse. They are carefully to be guarded from injury or pressure. Spina bifida is much less serious than the similar condition of the head, and children born with it may be otherwise well-formed and healthy. A pad should be carefully adjusted and fixed over the swelling so as to maintain all over it a moderate degree of pressure.

Defects in the Opening of the Bowel or Urinary Passages sometimes exist. They should at once be brought under the notice of the medical attendant.

Hare-lip.—Hare-lip or split-lip occurs on the upper lip, the split being on one side or other of the middle line, or on both sides. It is due to an arrest of development. For the upper jaw is formed by parts from each side growing inwards towards the middle line. They do not meet in the middle, but, in the gap left, growth takes place of an intermediate part which in time unites completely with the parts on each side, and thus the complete upper jaw is formed. This intermediate part it is which in the developed condition carries the four front teeth. Now hare-lip is an arrest of the growth at one period or another, the result of which is that complete union is not effected at one or other side or at both. The split may involve the soft parts only, or it may extend through to the bone. In the most extreme cases the central part of the upper jaw, including the bone and soft parts connected with it, is quite ununited with the rest of the upper jaw at each side. Often this central portion is projected forwards and upwards, standing straight out from the face, and sometimes it is so much twisted to one side as to block one nostril, out of which it seems to be sticking. In such cases the palate is cleft also, that is, the roof of the mouth is deficient in the middle line, owing to an arrest in the development of the bone, which should have grown forward till junction and complete union was effected in the middle line.

Cleft-palate in slight cases only involves the soft parts at the back of the mouth, the uvula, &c. (Fig. 101, p. 195). As it extends forward it involves the bone, till in extreme cases the cleft passes from back to front. There is thus no separation between the cavities of the mouth and nostrils.

When hare-lip exists alone, bone union being complete, the deformity is the only thing, and it can easily be remedied by an operation, which will leave little or no hint of the original condition. But when it is associated with non-union of the bone it interferes with suckling. This may sometimes be remedied by the mother using a nipple shield with a large nipple. When, however, the split is large and cleft-palate also exists, suckling is impossible, and even feeding is very difficult. Cleft-palate may exist alone to a greater or less extent. In many cases it is not noticeable till the child begins to speak, and then it is recognized by the peculiar nasal "twang". Both conditions can be remedied by operations. For hare-lip the operation should be performed before teething. It is not attended by danger, and its results in improving the appearance are remarkable. For cleft-palate there is no haste, but it should not be delayed till the child has learned to speak and has acquired the "twang". It is not nearly so simple an operation as the former. In extreme cases the separation may be too great to permit of closure by operation, but a plate may be made to cover the opening.

Blue Disease (*Cyanosis*) is due to an arrest of development interfering with proper aeration of the blood. While the child is still in the womb its own lungs are inactive and unexpanded. The aeration of the blood of the child is effected indirectly through the blood of the mother. The blood of the child passes in the vessels of the cord to the placenta, which connects the child to the mother, and is there purified by exchanges with the blood of the mother. Returning from the placenta the blood of the child passes to the upper chamber of the right side of the heart, partly directly and partly through the liver. In the adult the right and left sides of the heart are separated by a complete partition, but in the fœtus an opening exists through which the pure blood can pass directly through the right upper chamber to the left, and from the left side it is then distributed through the body. After birth this opening should close, and then the blood requires to pass from the right side through the lungs, where it is purified, before it reaches the left. In rare cases this opening remains unclosed, and thus while part of the blood passes through the lungs to the left side, part escapes directly from right to left without previously passing through the lungs, and thus without aeration. The blood is, therefore, constantly deficient in oxygen, and the blueness arises in consequence. The child's skin, its cheeks, lips, hands, and feet are markedly livid, the fingers and toes are clubbed and the nails are incurved. It breathes rapidly and is liable to attacks of breathlessness. In marked cases death usually occurs in a few days, in slighter cases life may be prolonged for some years. All that can be done is to keep the child quiet and to protect from cold.

Tongue-tie. — This condition is due to shortening of the bridle of the tongue. When it is present the child cannot push the tongue out over the lips; and it interferes with the suckling. It is easily set right by turning up the tongue and dividing the front of the bridle by means of a blunt-pointed pair of scissors. This should only be done by a medical man, for if the scissors be directed upwards, one of the blood-vessels running along the under surface of the tongue may be injured.

Cataract.—Children are sometimes born with white spots in the lens of the eye, interfering with sight, or the whole lens may be white, rendering seeing impossible. This is due to some defect of nourishment in the womb. The child should be taken early to an oculist, as an operation is frequently necessary very early to prevent changes arising in the eye that would interfere with the usefulness of an operation at a later period. (See p. 482.)

Congenital Dislocation at the Hip.—This is a condition in which, probably through faulty growth of the head of the thigh-bone, and the socket in which it should lie (see p. 63), the head of the thigh-bone lies outside the socket. The condition may not be discovered till the child begins to try to walk. It occurs usually on both sides, though it may be only on one. If both sides are affected, the child's back is arched forwards, the abdomen is prominent, the buttocks broadened, and the child waddles. If it is only on one side, the child walks with a rolling limp, and one leg is shorter than the other. This condition should always be one to make sure of, should a child make no attempt to walk, or should fail, at the usual time.

It can be remedied by operation. Professor Lorenz, of Vienna, treats such cases by manipulation and then fixing up the limb in plaster for a time.

Congenital Absence of Bile-ducts is a defect of development in infants, attended by jaundice, which is sooner or later fatal, at the latest within eight or ten months. It is due to the canals which should convey the bile from the liver to the bowel (see p. 201) being defective, so that bile is kept back in the liver. One result is that the motions are clay-coloured, and there is constipation. The child's skin is deeply jaundiced, and the urine highly coloured with bile. The liver and spleen are enlarged, and blood is apt to escape from various situations. The child becomes very emaciated but with prominent belly. Vomiting and convulsions are apt to occur, and death usually arises from exhaustion.

Congenital Obstruction of Stomach Outlet.—The junction of the stomach and the first part of the small intestine is called the pylorus. This junction may be unduly narrow at birth, making it difficult for the food to escape into the bowel. The technical word for narrowing is **stenosis**, and when it is at this place the stenosis is called pyloric, thus obstruction at the outlet of the stomach dating from birth becomes, in technical language, **congenital pyloric stenosis**. It is a very rare condition, so far as the record of cases goes, but the writer fears many cases may be ascribed to other causes.

Its chief symptoms are two—(1) persistent vomiting and (2) constipation. The child may appear perfectly healthy at birth, and may thrive, whether fed artificially or at the breast, for two or three weeks. But after two, three, or four weeks vomiting begins. It occurs daily, now and again, at first, but increases till it is after every meal. Change of food, sedative medicine, and so on may seem to diminish it for a brief period, but it recurs, and persists in spite of everything, so that the child rapidly becomes emaciated and exhausted. After the vomiting has begun, constipation becomes noticeable; when the bowels are moved, only bile-stained mucus is passed and little or no fæcal matter of the usual colour. When the child's belly is examined, a prominence is likely to be observed in the upper portion, between the navel and the end of the breast-bone, and a wave-like movement may sometimes be seen to pass over this region, due to excessive action of the stomach in the effort to force its contents through the narrow outlet. Symptoms of such persistent vomiting should lead to immediate appeal to a surgical expert, for in extreme degrees of narrowing there is no hope of saving the child's life except by an operation.

DISEASES OF THE NEWLY-BORN.

Ulceration or Bleeding at the Navel.—If the bleeding be from the attached piece of cord it should be tied a second time, nearer the belly. This may occur some hours after birth because the cord has been improperly tied. The clothing should be immediately undone and the cord tied again between the former place and the belly. Four or six strands of linen thread form the best material for the purpose. It may also occur owing to the remains of the cord being too early separated. If so, the bleeding is best stopped by gentle steady pressure with the finger or a small pad. It should not be allowed to continue, else the slow drain may be very hurtful. If the part be not healing properly, it should be carefully sponged frequently, and if necessary may be painted with an astringent like syrup of tannin, or tannate of glycerine.

Inflammation of the Eyes.—One form of inflammation of the eyes of a newly-born child, if not watched with great care, may ruin the child's eyes in the course of a few days, and render the infant incurably blind. It begins usually about the third or fourth day after birth. The eyelashes stick together, and the borders of the lids are red and crusted. Both eyes are attacked, the one after the other. The lids become swollen, and in a day or two thin fluid pours out from between the lids; the fluid in about a week has changed to matter, with which the eyes are constantly overflowing. The treatment consists in keeping the eyes scrupulously and constantly clean. Use warm water, and a soft rag or lint: *open the eyes thoroughly, turning out the lids, and cleaning away every particle of matter.* To the warm water a few drops of Condy's fluid, sufficient to make the water slightly pink, may be added. *This must be done not once nor twice daily but very often, so that no matter is allowed to accumulate in the eye.* No ointments should be used. The inflammation, however, is of so dangerous a character in its effects upon the sight that no time should be lost in having proper medical treatment.

Jaundice.—This is not uncommon during the first or second week of infant life, the skin and white of the eyes becoming quite yellow, and the stools colourless. It is not to be feared. Usually no remedies are required. It will pass off often as quickly as it came. If it is excessive give a small dose of castor-oil only.

Jaundice due to absence of bile-ducts is noted on p. 594.

Swelling of the Breasts.—This is not infrequent in newly-born children. The breasts are firm and tense, and occasionally fluid like milk oozes from them. *They should not be squeezed or pressed in any way.* Gentle rubbing with warm oil is often all that is necessary. Where redness or a purplish tinge indicates a more severe form of swelling, a soothing poultice of warm bread and water should be applied, or a warm sponge held on them each time the child is bathed.

Retention of Urine and Stools.—This may be caused by some defect already alluded to (p. 593). The nurse is never, by any means, to give "nitre" in the hope of causing the child to make water. She may use a warm bath, or place warm cloths over the lower part of the belly, and that usually will be sufficient. The attention of the medical attendant should be directed to the child if this is insufficient.

Undescended Testicle.—The testicle should pass from the belly, down a canal in the groin, into the scrotum or bag, about a month before birth. At any point of its passage it may be arrested, and thus remain in the belly, or in the canal, or just at the upper part of the bag. Every male child should be examined after birth in this respect, as trouble may arise in later years if the testicle is imprisoned in the canal.

Moles and Mother's Marks.—These have been sufficiently considered on pp. 327 and 430.

DISEASES COMMON TO CHILDHOOD.

AILMENTS AT THE PERIODS OF TEETHING AND WEANING.

The period of teething is undoubtedly a time when the child is easily upset, restless, and highly excitable, and, therefore, more liable to ailments than at other times. But it is quite certain that to the teething process is attributed all sorts of trouble, due rather to careless nursing and bad management. In some cases the child is dosed with medicines of one kind or another, in other cases the excuse, "Oh! it is just the teeth", is given for every disturbance of health; and without much further thought the mother or nurse waits on time to remedy the ailment, when the teeth will all have been cut. Both methods are mistaken. It is not to be forgotten that the child is at a stage of development when it is in a peculiarly sensitive condition, but just for this reason more watchful care is to be exercised, and, while medicines are avoided, more attention is to be paid to good management. Disturbances of stomach and bowels are common, looseness of bowels especially. These are to be met by careful nursing and dieting, as indicated on p. 581. The same careful management will diminish the restlessness and excitability of the child. If, however, the bowels being free and regular, the child is much disturbed, mothers often feel they must give something to calm and soothe. Again it is necessary to repeat the warning against so-called soothing syrups, given on p. 573. One drug, however, may be given to calm the nervous system, and it is devoid of danger. It is bromide of potassium. Let 32 grains be dissolved in a little water and made up to one ounce, that is eight tea-spoonfuls, with simple syrup. Of this a tea-spoonful is given occasionally, but not frequently repeated. Lancing the gums, so often resorted to, is as a rule a barbarous practice, and is never done by modern physicians, unless the gum over the coming tooth is distinctly dark and boggy looking, and the tooth near the surface.

Inflammation of the Gums does justify the procedure, and is greatly relieved by it, and that even though the tooth be not yet near the surface. The inflammation is readily known by the swollen state of the gum, and its dark-red appearance. In such a case, when the tooth is yet deep in the gum, the lance should be applied to the side and not over the coming tooth. For, if the wound heal before the tooth is cut, the scar is likely to make the cutting of the tooth more difficult.

At the period of weaning, disorder of stomach and bowels is frequent. This difficulty may also be overcome by management. If the child's bowels are very troublesome, the mother had better delay the process for a little and then try again, or effect it very slowly.

COUGHS, COLDS, AND AFFECTIONS OF THE CHEST.

Cold may take the form of running at the nose—**snuffles**—(preceded by frequent sneezing), watery eyes, some degree of feverishness, and the child is cross. This is a form of what is called "catarrh", from two Greek words meaning "a running down" (see p. 214). It may extend from the nose to the throat, causing it to become red and swollen, may pass down into the windpipe, and may also cause a similar condition in the stomach, called catarrh of the stomach. In these severer forms there will be loss of appetite, white tongue, and if the child can speak it may complain of headache and pains in the back or limbs. Whether the attack be mild or severe, simple treatment is all that is required, that is, give the child a warm bath, keep it warm in bed, give gentle opening medicine—castor-oil—at once, let it be fed on milk only, and give, thrice or so daily, 3 to 5 drops ipecacuanha wine. If the nose is very much obstructed, some relief may be given by laying over it a sponge squeezed out of hot water, or by spraying into the nostrils by means of an atomizer (Plate XLVII.). This is all the treatment that should be adopted without medical advice. This affection may, however, go on, the lungs may become affected, and bronchitis or other disease of the chest result.

Bronchitis (p. 363).—This will be attended with quick, hurried breathing, with flushed face, and other aggravated signs, with a moderate degree of fever and quickened pulse. Cough is present and may be incessant, at first hard and dry, and later loose and rattling. But infants and children in general do not put up any spit, which, coughed up out of the windpipe, passes over into the gullet and down to the stomach. Reference to fig. 101, p. 195, will show how this happens.

The ear applied to some part of the chest may detect wheezing or piping sounds. These are too serious forms of disease to be delayed over, and medical aid should speedily be secured.

Treatment.—Till medical advice is obtained, the child should be put to bed in a room kept at a uniform warmth of 60° Fahr. A fire should be kept up, large or small according to the state of the weather.

The diet should be restricted to milk of a strength suited to the age; and the bowels should be opened daily by a small dose of castor-oil.

The air of the room should be kept moist by means of the bronchitis kettle. Often a small tea-kettle with spirit-lamp will suit the purpose, if placed on a table by the bed-side. If the water be boiling in the kettle, before the kettle is put over the spirit-lamp, the lamp will be sufficient to keep it steaming. Two or three drops of ipecacuanha wine may be given in water every three or four hours if the cough is dry, five or ten of syrup of squills if it is loose.

Only if these measures fail to give relief, should a poultice be applied. If used, it is best applied all over the back, not the front; and if any mustard be added to the linseed-meal, it should be little, not more than one dessert-spoonful to four table-spoonfuls of meal.

The child should be kept many days in bed, after the attack is over, to avoid a recurrence and the establishment of a chronic condition.

Asthma in childhood does not materially differ from the same disease in the adult. The nose and throat in children subject to it should be carefully and thoroughly examined, and any thickening, obstruction, adenoids, &c., dealt with. See p. 598.

Pneumonia in the child may be ushered in by an attack of convulsions. The temperature rises quickly and high, the pulse is greatly quickened, the face is deeply flushed, the skin dry and hot. There is a short, hard, dry cough, and breathing becomes very rapid, 50 or 60 per minute or more frequent, the movement of the nostrils showing how embarrassed is the breathing. In five or seven days the fever suddenly ceases, breathing becomes easier, the skin moister, the pulse slower, and the child free of the oppression under which it was labouring.

The treatment of such a disease must never be in any but trained medical hands. Without medical advice, the directions given under bronchitis, about the room, diet, bowels, &c., should be followed, and if the temperature rises very high, and the child is profoundly oppressed by it, cold sponging as suggested on p. 510, or the fever mixture on p. 511, may be employed with caution, and provided only competent medical advice is unobtainable.

Broncho-pneumonia is a more frequent form of pneumonia in children. It may begin very like the ordinary type just described, or it may occur as a consequence of some other disease, such as measles, diphtheria, whooping-cough, or bronchitis. It has not a definite duration, like ordinary pneumonia, but after two or three days high fever, the temperature yields for a day or so, and then the fever returns, and so on, relapse after relapse occurring, as the disease spreads from one bit of lung to another.

Little can be added here to the directions given for the treatment of pneumonia. Exhaustion is common in this form, and stimulant frequently necessary. It is best given in the form of whisky in milk. A tea-spoonful of whisky should be added to each tea-cupful of milk or milk mixture (see p. 565), and from 4 to 8 of such cups might be given in 24 hours.

Pleurisy (see p. 359).

Croup (see p. 539).

Cough is present in most of the above affections, and is to be treated as described for cold. But, not infrequently, especially when the back part of the throat is evidently red and congested, the cough may be very irritating and even suffocative. This is often relieved, in addition to the means already mentioned, by putting a small, mild, hot poultice on the front of the neck, just over "Adam's apple", and giving repeated small doses of ipecacuanha wine, and if necessary by using the steam from a kettle as noted above.

There is a cough, however, which should rouse instant attention, a hoarse muffled cough "like the distant bark of a puppy", or a cough with a ringing metallic sound—a brassy cough. Let the mother or nurse be on guard against croup, of which this is strongly suspicious. (See p. 539.)

Scrofula and Consumption.

Refer to pp. 551 and 372.

Mothers who are concerned about the delicacy of some child should take special pains in guarding and rearing it, after the manner suggested on pp. 386 and 552.

AFFECTIONS OF THE NOSE, THROAT, AND EARS.

Obstruction of the Nostrils and **Discharge from the Nose** are extremely troublesome ailments in young children, because the nasal passages are so narrow that the slightest catarrhal swelling blocks them entirely. The child cannot breathe through the nostrils, and is restless and disturbed.

The nurse should always make certain that no foreign body is in the nose, causing the swelling and discharge. The discharge should be regularly cleansed away by means of a very gentle stream of water containing soda and borax in solution. A large wine-glassful of water should contain a mere pinch of bicarbonate of soda and borate of soda (to be exact 10 grains of each) and the water should be warm. A syringe may be used to gently wash the nostrils out, or a fine spray may be employed.

When the acute stage has passed, an oily application is best, olive-oil or paroleine may be used containing 1 grain menthol and 1 grain camphor to each ounce, and this may be dropped into the nostrils by a dropper, or sprayed also by a fine spray.

Hypertrophy of the Lining Membrane of the Nose is a condition in which the lining of the nostrils is greatly thickened, and the fairway narrowed. The slightest cold or irritation of the nose blocks it completely, so that the child seems to be continually catching cold. It is in older children this condition develops, not in infants—at least in children after two years of age.

The children are restless, nervous, breathe noisily in sleep. They frequently suffer from headache, and any little cold is apt to end in asthmatic or bronchitic attacks.

Such children breathe by the mouth, and have in consequence a facial expression suggesting dulness and stupidity, going about as they do with open mouth and hanging lower lip. Hearing is very liable to be impaired.

The thickening in these cases is due to overgrowth of the kind of connective tissue which abounds in the deeper layers of the mucous membrane. This tissue is called **adenoid tissue** (p. 277). Here and there in the mucous membrane of nose and throat, tongue, and elsewhere, this tissue forms little clumps, and when the tissue has for any cause increased to excess, these clumps become prominent and cause the free surface of the mucous membrane to be thrown into little mounds. Such irregularities of the free surface of the lining membrane of nose and throat may vary greatly in size, from that of a tiny pin-head to that of a pea or a nut. They are called **adenoid overgrowths**, or **adenoid vegetations**, or, shortly, **adenoids**. Such little elevations of the surface may easily be seen on the back wall of the throat in lymphatic children, if the throat be examined in a good light. When they form considerable masses in the space above the mouth, with which the back openings of the nostrils communicate—the **naso-pharynx**, as it is called,—they block the nostrils, and also the tube passing from the ear to the throat on each side, the eustachian tube. Deafness is a common result of such conditions in children. The space referred to may be seen in section in fig 101, p. 195. It is the continuation upward of the gullet between the lines *b* and *w*.

Any child who breathes persistently through the mouth, or is noisy in sleep, or goes about with hanging lip and open mouth, and is dull of hearing, should have the nose and the naso-pharynx carefully examined, and no delay should be permitted in the removal of any growths present.

The operation is a very simple one in these days, devoid of danger when done by one who knows his work, and may be done without pain to the child, either at the time or subsequently, by the use of one of numerous anæsthetic agents now available.

Inflammation (Quinsy) and Hypertrophy of Tonsils.—The tonsils are special clumps or masses of adenoid tissue, as above described, which readily take on overgrowth with repeated attacks of inflammation. Such overgrown tonsil masses should be removed. See p. 216.

Bleeding from the Nose may be controlled by the application, over the bridge of the nose, of sponges soaked in cold water. If it occurs frequently without known cause, let the child's health be inquired into. If it is a stout, evidently full-blooded child, keep the bowels free, and let the diet be very simple. If, on the other hand, the child is delicate, it should have an iron tonic, like chemical food, and cod-liver oil, and plenty of nourishing food.

Discharge from the Ear, Earache. See p. 490.

Foreign Bodies in the Nose and Ears, &c.—(1) If the body is in the nose, the child should be made to take a deep breath, then the free nostril is closed, and a strong effort to blow through the blocked nose will often succeed in dislodging the substance. (2) If the body is in the ear, syringing may be used if *the body is not a pea or a substance that can suck up the water and swell.* Pins, bodkins, &c., should be used with the utmost care, especially in the ear, where a slight thing will injure the delicate drum of the ear and destroy the power of hearing on that side. (3) If a child has swallowed a pin, a coin, or other foreign body, purgative medicines should not be given, nor much fluid food, but plenty of soft food, like porridge, rice, corn-flour, saps, &c., which may surround the body and prevent it injuring the stomach or bowels. Plate VII. shows how useful an X-ray photograph may be in locating something swallowed.

AFFECTIONS OF THE MOUTH, STOMACH, AND BOWELS.

Thrush (*Aphthæ—Sprue*).—In this disease the tongue and inside of the mouth are covered by white patches of a peculiar growth, sometimes forming a continuous white crust. It is often accompanied by disordered stomach and bowels, particularly if the child be weakly. The patches are really due to the growth of a minute microscopic plant, flourishing because of the unhealthy state of the digestive canal.

Treatment. (1) Give mild opening medicine—magnesia with a little rhubarb. (2) Correct at once any errors in diet. (3) Apply to the mouth borax and honey, or glycerine with an equal part of solution of borax, or chlorate of potash (20 to 30 grains of either to an ounce of water). The disease will not be properly cured unless the disordered stomach is set right by proper dieting.

Ulcers on Lips and different parts of the mouth occur readily in children whose stomach and bowels are in bad condition. Treatment is the same as for thrush.

Inflammation of the Mouth of an extremely serious kind is seen in weakly, ill-fed children, living in large towns, in badly-aired apartments. It frequently follows on measles or other weakening disease. It begins as an ulcer, of a dirty ash-gray colour, on the lip or inside of the cheek, and eats its way into the cheek and gums. The face is swollen, saliva dribbles from the mouth, the breath is foul-smelling, and the teeth may drop out. The pulse fails, the stomach and bowels become disordered, and death results, often very rapidly, from exhaustion.

Treatment requires first of all to be directed to cleanse the stomach and bowels by a dose of rhubarb and magnesia. Nourishing food must be freely supplied, but in small quantities given often, milk and beef-tea specially. Wine is frequently needed to combat the feebleness. A mixture of chlorate of potash, 60 grains, syrup, 1 ounce, and water, 3 ounces, should be obtained, of which one to two tea-spoonfuls should be given every four hours. The mouth should be bathed with a solution of 30 grains chlorate of potash to 1 ounce of water.

Derangements of the Stomach and Bowels.—These are oftenest due to improper feeding; they also are frequent at periods like teething, weaning, and so on. They may be due to excessive quantity of the milk or altered quality. If the child be at the breast it may have been too frequently suckled, or, owing to some condition of the mother, or some improper food taken by her, the quality of her milk has been changed. This can be easily remedied. If the child is not at the breast the quantity and kind of food it is getting must be seen to. Similarly, too sudden weaning, or irritation due to teething, may be the cause. If the cause can be discovered let it be removed at once, and probably, without further steps, but simply under the influence of proper food, given at proper intervals and in the right quantity, the child will be restored.

A careful reading of the directions given in the immediately preceding section regarding the diet at various ages will materially help the mother or nurse to decide whether the child is being properly handled or not.

If there seems reason to believe that errors are being committed, the sooner the person in charge of the child begins afresh the better. Let the food be prepared to suit its age, let small doses of castor-oil be given morning and evening for a day or two, say half to one teaspoonful, till the bowels have been, *not* freely purged, but only gently moved each day, and till the motions have become of a uniform pulpy appearance, free of lumps, and of a good yellow colour. Probably, meantime, the child should be kept at rest.

Simple treatment like this will in a few days clear up the large majority of cases.

Above all, let dosing, by unskilled persons, with drugs be avoided.

Vomiting may be the result of some simple stomach derangement, the consequence, for instance, of overfeeding or a chill. On the other hand, it may be a symptom of the gravest possible disorder, demanding rapid steps to avert disaster.

For instance, it may be due to irritation of the stomach by too much, or badly prepared, food, or improper food, or food that has gone sour or is tainted and undergoing chemical change. But it may also occur when there is no irritation of the stomach itself, the irritation being in some other organ. Thus it is a frequent occurrence in tubercular disease of the brain in its earliest stages, and it is a constant symptom in obstruction of the bowel. In such cases the stomach is made to empty itself by a reflex nervous action starting from the distant organ which is the real seat of the irritation. But how is a mother or nurse to distinguish between the simple and the serious condition? The answer is that the mother or nurse should not try to do so if she is within reach of competent medical advice. The risks are too great. Delay is too dangerous. In the serious condition twelve hours' delay may make all the difference between successful treatment and a hopeless situation.

But this book, it is recognized, is primarily meant for those who are far from proper medical help, or for those to whom the summoning of the nearest but yet distant doctor is a serious financial consideration if only a trifling ailment is concerned.

Persons who are in such circumstances should be in some measure prepared, if they have children to care for. They should be provided with a thermometer and know how to use it. The temperature in such cases should always be taken in the bowel (see p. 38).

The vomit should be carefully inspected as to its general appearance, and specially its colour, and any motion similarly inspected.

A child, then, is seized with an attack of vomiting, under circumstances which render medical aid impossible for many hours; what is the mother or nurse to do?

The child should be stripped, put to bed, and its temperature taken in the bowel, and the amount and hour when taken noted down in black and white.

All food and even water is to be stopped for a time, and the bowels are to be cleared by a water or oil enema (see p. 592); no drugs are to be given.

If medical help has been sent for and will arrive in an hour or two, the doctor's arrival should be awaited and nothing else done.

But we shall assume no medical help is near. The person in charge is compelled to try to come to some sort of conclusion.

If the temperature is normal, or below it, that is 99·2° in the bowel, or lower, no conclusion can be drawn, but if the temperature is above this level, something is wrong somewhere. The temperature should be taken at regular intervals, say every three hours, and carefully noted. If a temperature, at first below normal, in an hour or two rises to normal, and remains there, not going above, the probability is the disturbance has been trifling and is over, but if it is found above normal, or, originally low, goes above normal and remains so, there is mischief going on, and great care must be exercised.

The temperature having been taken, the next thing the person in charge should do is to uncover the child's belly, the child lying on its back, and carefully to note whether it is anywhere unduly bulging or unduly rigid. The warmed hand should then be gently laid flat on the child's belly and moved gently over it, in the endeavour to discover whether there is any place painful to pressure. The unskilled person cannot be expected to learn much, but often will be able to make out that the child is uneasy, or cries or wriggles, when the hand presses over one particular place. If the child is old enough to do so, it will say where there is pain, though one must be on one's guard against being misled by a nervous child. But if the child is old enough, it should be asked to put its hand on the painful place. After it has done so, the child's attention should be drawn to something else, and then, after a minute or two, it should be again asked to lay its hand on the painful place. This manœuvre may be several times repeated, in order to discover whether the child always lays its hand exactly on the same place. If it does so, the mother or nurse should then try whether gentle but firm pressure with the points of two fingers over this place causes complaint by the child.

More or less persistent vomiting, accompanied by a raised temperature, however little, and by a painful area or spot in the belly, is strongly suggestive of appendicitis (see p. 247), intussusception (p. 604), or obstruction (p. 253), while if the belly is prominent and tender all over, peritonitis is to be feared (p. 265).

Vomiting, temperature, and pain in the belly, when associated in a child, are symptoms of the gravest kind that must never be treated lightly.

The paragraphs dealing with each of these ailments should be referred to for further information.

The cases in which vomiting is a symptom of very grave character have been referred to first to emphasize the warning meant to be conveyed. But, of course, such cases, though every now and again occurring in most unexpected fashion, are few in comparison with the multitude of cases of vomiting due merely to some error of diet.

In the case of a child at the breast, vomiting is common when the child is permitted to suck too fast and too long, and so to overload its stomach. In such cases the milk is vomited almost unchanged, and the child immediately after appears perfectly well and of good colour. The suckling should, in such cases, be at longer intervals and the mother should endeavour to make the child drink more slowly, should take the breast away every minute or two, and should not press it on the child after it seems to be satisfied. But a constant overloading of the infant's stomach may speedily induce an extreme degree of irritability, the child is fretful and whining, sucking greedily but never satisfied, and probably losing flesh and colour.

In such a case the child must be permitted to take only very small quantities at a time, repeated at shorter intervals, and as the vomiting ceases the amount is increased and the interval lengthened. If the child is being fed by bottle or spoon, there is no difficulty about regulating the amount with accuracy. The mother or nurse should quickly discover how much can be taken without vomiting being induced, nothing more than a tea-spoonful of the "milk mixture" appropriate to the age being given every 15 minutes. After a few hours, if vomiting has ceased, the quantity may be increased to 3 tea-spoonfuls every half-hour; if this is retained, 2 table-spoonfuls every hour may be given, and so on.

A warm poultice over the stomach will also help.

Vomiting, persistent no matter what or how little is taken, occurs in disorder of the stomach from cold. If the plan already advised, one or two tea-spoonfuls at a time and at brief intervals, and warm applications over the belly, does not arrest it, then let some ice be obtained. A few pieces should be put into a glass of fresh milk, and the whole allowed to stand till the milk is ice-cold. Of this give the child a tea-spoonful, or at the most two every half-hour or so, and apply warmth outside. After the lapse of some hours give the iced milk less frequently, and give one or two tea-spoonfuls of ordinary milk between the doses. The irritability will almost certainly yield to this method, and gradually larger quantities of ordinary milk at longer intervals may be given. *It is needful to avoid giving any considerable quantity of the iced milk at a time, for that would be hurtful.*

Vomiting accompanied by a white-coated tongue, loss of appetite, and a sickly sweet smell of breath is common in children. It is usually easily overcome by rest in bed, small quantities of "milk mixture" (p. 565) at regular intervals, and clearing the bowels (p. 591). In this case bicarbonate of soda frequently proves to be a valuable remedy, as much as can be lifted on a sixpenny-piece, dissolved in half a wine-glassful of water, may be given in tea-spoonfuls at a time, and repeated thrice daily. The child usually is plagued with thirst, and enjoys the water, even with the soda.

Persistent Vomiting, yielding to no remedy, in an infant of a few weeks old, should lead to the suspicion of obstruction at the stomach outlet (see p. 594).

Colic and Flatulence are manifested by the infant suddenly becoming fretful. It draws up its legs towards the belly, and cries for a time, and then returns to its usual state. This is repeated on another attack. The distress may be great and the pain long, shown by the long-continued screaming and violent movements of the legs, and it may be relieved by a discharge of wind or stools. Here, again, look to the food the child is receiving. Get rid of any irritating matter by giving a dose of castor-oil, after which magnesia in doses of 3 to 5 grains, or fluid magnesia, 1 to 2 dessert-spoonfuls, may be given occasionally if required. When the colic is present, rubbing the belly with the warm hand, or applying hot cloths, will relieve it. The only other remedy that the mother or nurse should use is dill-water, of which half to one tea-spoonful is sufficient, or essence of anise, 5 drops on sugar.

Diarrhœa is one of the chief symptoms of disorder of the bowel, as vomiting is one of the chief symptoms of disorder of the stomach. It has been fully considered on p. 242. But in the case of children, and specially of infants, even a simple diarrhœa may in a few hours bring the child into a condition of grave danger, because of the rapid exhaustion it is capable of producing.

Mothers and nurses should note that in infants and young children there are two forms of diarrhœa.

Simple Diarrhœa, due to some error in diet;
Summer Diarrhœa, due to milk-poisoning.

It must not be supposed, however, that the former, because it is called simple, is not serious; on the contrary, if not promptly treated, it may become most serious; but the second form is of the gravest possible kind from the very commencement, and is rapidly fatal to young children.

Simple Diarrhœa is due usually to improper feeding, either because the wrong kind of food is given, or because too much is given at a time, or because it is given too frequently. The child usually suffers from griping pain, followed by the discharge from the bowel. It is restless, squirming and kicking with the pain, usually lying quiet and exhausted in appearance in the intervals. There may be a little feverishness, and if the irritation of the bowel be severe there may be convulsions. Similar symptoms may be produced by other conditions within the abdomen, besides mere intestinal irritation, and it would be proper for the nurse to examine the belly, in the manner described in the paragraphs on vomiting (p. 600), unless medical aid is speedily obtainable.

In all cases of diarrhœa the material passed from the bowel should be carefully examined, and, when the doctor has been summoned, kept for him to see. In the case of older children, when the motion has been passed into a vessel, it may be rendered perfectly inoffensive by pouring over it a couple of pints or so of cold water, in which two tea-spoonfuls of common salt have been dissolved. In the case of infants the soiled napkins should be placed in a vessel, a chamber utensil, kept covered with a damp cloth and a lid if possible. In all cases the vessel containing these things should be kept in a corner of the bath-room, the door of which is shut and the window open, never in the nursery or sick-room.

It makes one's flesh creep to see how mothers and nurses handle such soiled napkins, dropping them on to the floor, or a chair, or pushing them under the bed with the foot, and to observe how, after handling them, the mother or nurse will go, with unwashed hands! to look after the child's food.

In the case of simple diarrhœa from overfeeding, the motions are at first semi-solid, somewhat greenish, and pieces of white curd are scattered through the motions. If the motions are distinctly green, these little lumps of curd may be stained, but, if cut into, even the small pieces will appear quite white inside, and will be quite clearly curd of milk.

Meantime two things should be done—all feeding should be immediately stopped for several hours, and a tea-spoonful of castor-oil should be given to sweep all offending matters out of the bowel. In four or six hours the castor-oil may be repeated in half tea-spoonful doses, till the bowels are satisfactorily cleansed, as shown by the character of the stools. During this time, though food is not given, water ought to be given, and preferably water containing half a small tea-spoonful of salt to a tumbler of water, boiled and then cooled and kept covered. A tea-spoonful of this may be regularly given every half-hour.

Warmth to the belly, applied by a piece of flannel wrung out of water, comfortably warm, will be found useful. Medicines other than castor-oil should be avoided, and opiates are too dangerous, except in the hands of those who know how to use them.

These steps will usually be sufficient. In six or twelve hours the child should be comfortable, and indicating its hunger.

But feeding should be resumed very cautiously. What has been said about the suitable diet according to the child's age should be referred to on p. 565, and those which follow. The best way would be to make a little of "the milk mixture", suited to the child's age, to add a table-spoonful of that to two table-spoonfuls of the boiled water with salt, and to go on giving tea-spoonful doses of this "milk mixture" and water every half-hour. The child remaining comfortable, in a couple of hours the proportion of "milk mixture" should be increased to a half, and tea-spoonful doses given as before. If this continues to agree "the milk mixture" should again be increased, say 3 of "milk mixture" to 1 of water with salt, and so on till "milk mixture" alone is being given.

The quantity of "milk mixture" could then be increased and the intervals lengthened till full quantities and intervals were gradually restored.

Chronic Diarrhœa is apt to arise from a continuance of improper feeding. The child becomes fretful, emaciated, sleepless, much troubled with wind in the bowels, the skin around the outlet of the bowel being red, very tender, and excoriated, and the bowel frequently comes down.

The motions in this case are semi-solid or watery, the lumps of undigested curd and fat from the milk are easily distinguished, and they are usually coated with mucus stained green in many cases. The smell is usually very offensive. Sometimes the motions are more clay-like; and the odour of such stools is apt to be even worse, because of the absence of bile, which is the great deodorizer of the motions.

Sometimes the motions are frothy, speaking of rapid fermentative processes going on in the bowel. In all of these cases feeding should be stopped for 6 or 12 hours, castor-oil should be given in repeated small doses, as suggested for simple diarrhœa. When the stools are clay-like, ½ grain of calomel may be given and repeated every 12 hours, instead of castor-oil, and the slightly saline water given freely by the mouth, as the child is usually thirsty and the mouth dry. If there is much exhaustion a few drops of whisky or brandy may be given with the saline water. Besides these steps, it would be well to wash out the bowel. For this purpose tepid water should be used, in every pint (2 tumblers) of which a small tea-spoonful of table-salt has been dissolved. This water should have first been boiled and then kept in a perfectly clean vessel, protected from dust, till cool enough for the purpose. It should be injected by means of an enema syringe which has previously been soaked in boiling water containing a tea-spoonful of soda to every pint. The rubber tube, supplied for going over the bone-end of the enema delivery-tube, should be put on, having become thoroughly soft by soaking in boiling water, and being oiled with clean pure olive-oil. Care should be taken that there is no air in the enema, the tube should, with a spiral movement, be gently passed up into the bowel as far as it will go, and the water very gently injected. The child is best lying on the nurse's knee, the nurse being protected by a rubber sheet over the knees, dipping into a small child's bath. A warmed towel is placed on the rubber, on which the child rests. The person injecting the water sits at the side on a low chair or stool, not directly in front of the child, lest a spurt of water from the bowel be shot over him.

If the water be slowly injected, if care be taken that its outflow from the bowel is not hindered, there can be no danger in using several pints of water; that is to say, ½ pint or so would be injected, then allowed to escape, then another ½ pint injected and allowed to escape, and so on, till the water returned unsoiled.

After 6 or 12 hours, feeding would be resumed; but it would in such chronic cases probably be best resumed with egg-water. This is made by stirring the white only of one egg in two tumblers of cold boiled water. The egg is not whisked, only broken up in the water by means of a fork or spoon. It is then strained through cloth and very slightly sweetened. The whole of this quantity may be used in 24 hours, being given in frequent spoonfuls.

Improvement being maintained, "milk mixture" may gradually be added to the egg-water in a way similar to that described for the addition of "milk mixture" and saline water in simple diarrhœa.

The only medicine other than castor-oil or calomel which may be given by unqualified persons is the carbonate or salicylate of bismuth, which may be given in 5-grain doses from four to eight times in 24 hours, according to the age of the child.

In some cases, after 24 hours of the white-of-egg drink before milk is resumed, it is well to wait other 24 hours and to give the white-of-egg drink and a weak chicken or mutton broth turn about.

Summer Diarrhœa of Children (*Cholera infantum*) differs from the preceding forms of diarrhœa in that it is due to an actual form of poisoning, the poison or toxin that plays the mischief being produced by the activity of living organisms which have gained entrance to the milk.

It prevails in summer and hot weather, and is the cause of the high mortality of infants in cities and poor, overcrowded districts, where unsanitary conditions abound.

The attack is usually sudden, vomiting and purging setting in together. The vomit is at first of the partly-digested milk, and then of bile-stained mucus; the motions are at first of undigested food, but they soon become watery and very abundant, and *colourless.* The loss of water from the body is so great that the child soon becomes greatly exhausted, hollow-eyed, pale as death, and rapidly emaciated. The temperature rises, the pulse is weak and thready; the child is very restless, and thirsty; its breathing is hurried; and it may become convulsed or stuporous.

Treatment, to have the least chance of success, must be rapid and energetic. The child is suffering from the effects of a poison introduced in milk, and irritating both stomach and bowels. Therefore to give no more of the material that may contain the poison, and to wash out, so far as possible, what has been already given, are the obvious things to try to do.

Feeding with milk must therefore be completely stopped. The bowels must be washed out with water, as directed on p. 603.

If the stomach could also be washed out with the saline water, it ought to be done; but in the absence of a qualified person this could not be done.

If the stomach cannot be washed out, small doses of calomel ($\frac{1}{4}$ grain) should be given and repeated every 4 hours for 24 hours. If castor-oil could be retained, it would be good to begin with one or two tea-spoonfuls, and thereafter to give the first of the repeated doses of calomel. Ice-cold boiled water, with the slight addition of salt (see p. 602), and with the addition of whisky or brandy if necessary, should be the only thing given by the mouth for the first 24 hours. The white-of-egg water, made with boiled water which has been cooled, should follow, the saline water being continued, with stimulant if necessary. After other 24 hours, warm, weak meat or chicken broth may be tried.

Artificial foods and meat extracts must not be used.

Finally a cautious return to milk food, as directed on p. 603, is made, the utmost care being exercised in the preparation of "the milk mixture" and its preservation from contamination. If, at the outset, the temperature runs high, an ice-cap to the head may be advisable, and cold sponging, with friction to the limbs. On the other hand, when a pinched and livid skin suggest collapse of the child, a warm bath to restore the circulation may be the best remedy—a bath of a temperature of 100°.

Laudanum ought never to be used.

Intestinal Obstruction as it occurs in children is in the form of **intussusception**, in which one part of the bowel slips into another part, as one part of the finger of a glove may be made to slip into the neighbouring part. It is met with in infancy and early childhood, the male child being more liable to it than the female. It is occasioned by irregular action of the bowels, sometimes set up by improper food, by the presence of worms, or by diarrhœa. It is very liable to be misunderstood, the illness being taken for an attack of colic or diarrhœa, for though proper motions are not passed, a bloody discharge is.

The **symptoms** arise suddenly with severe pain, which may cause convulsions. Vomiting soon occurs, and the *vomit is often streaked with blood and in a short time becomes smelling of fæcal matters.* Blood is frequently passed in the stools. On examining the belly the mass of obstructed bowel may be detected as a sausage-like swelling. The child may die in a few days of shock or exhaustion.

If the parent or nurse waits till the symptoms quite clearly indicate the nature of the ailment, all chance of saving the child's life is probably gone. Now the first motion after obstruction has occurred is likely to be of material lying in the lower bowel, material quite unaffected by what has occurred above. Any motion containing blood, or black because of altered blood, will not be passed for some time, perhaps a considerable time after the obstruction has taken place. For a similar reason the first vomit is likely to be of merely watery material and partly digested food, and the suspicions vomit, which is chocolate-coloured or coffee-like because of admixture with altered blood, and foul because of containing fæces, is not likely to occur for some time. Motions and vomit of such character, in an infant, following sometime after the child has suddenly become ill with pain in the belly, very clearly indicate what has occurred; but by this time it is too late to do anything with much chance of success.

A group of symptoms, much slighter than these, if associated, justify the fear of obstruction and prompt action to overcome it. That group of symptoms is as follows:—

(1) Sudden pain in the belly in an infant or young child, indicated by the child suddenly crying out, squirming, and kicking.
(2) Equally sudden pallor of countenance, often the skin of the whole body becomes pale; and the paleness is intense and persistent, and is due to the nervous shock caused by the pinching of the bowel.
(3) Vomiting, which persists if food is given.
(4) Rapid pulse, not associated with a high temperature.

The temperature, which should be taken in the bowel, is at first likely to be depressed by the shock; nevertheless the pulse is quick and thready. After some hours the temperature is likely to rise, though it may not rise more than one or two degrees; the pulse becomes still faster; nevertheless the pallor of face and skin remains.

If, with this group of symptoms, some tenderness can be made out over a limited area of the belly, the probability of obstruction is great. In the absence of a doctor, the olive-oil should be injected, as stated below, and gentle pressure on the outlet of the bowel made to help retain it while the belly is gently manipulated, the operator's hand being soft and well warmed.

The treatment must be prompt. Vomiting of material from the bowel, and the discharge of blood, should lead to help being instantly obtained. *Purgative medicines do harm.* The mother or nurse may, by means of an enema syringe, inject into the bowel, slowly and carefully, pure olive-oil slightly warmed. This may be done up to 10 ounces in the hope of releasing the obstruction by filling the bowel, and so causing it to slip up out of its unnatural position. If the oil is expelled from the bowel, a second 10 ounces may be injected within half an hour.

Costiveness.—It must be noticed that some children are costive by habit, and have motion only once in two or three days. It must also be remembered that frequent dosing with medicine is itself productive of costiveness, and is otherwise injurious. Medicines should therefore be avoided as much as possible, and reliance placed on proper dieting and on training the child to regular habits—to train it to seek relief at, as nearly as possible, the same time every day, say after breakfast.

Children brought up on the bottle are likely to be more troubled with constipation than breast-fed children, and boiling the milk tends to make it constipating. In these cases it is often possible, by varying the amount of sugar and cream in "the milk mixture", to hit the proportion that suits the child. For it is well to remember that milk deficient in cream makes a firmer curd, and so encourages constipation while the form of sugar in golden syrup encourages the movement of the bowel more than cane-sugar.

In older children constipation may be overcome by substituting brown for fine white bread, by the use of large-grain oatmeal porridge, or wheat-meal porridge, by increase in the diet of vegetables and fruits.

It must not be forgotten, also, that daily active exercise is of great value.

When medicine is necessary, castor-oil or olive-oil should be given. Olive-oil—the finest Italian olive-oil—is an excellent remedy, and has the advantage of being more of a food than a medicine. Children take it quite readily. One should begin with a small dose, say a teaspoonful given without addition the last thing at night and the first thing in the morning. The nightly dose is gradually increased, till the desired result is obtained of a soft, pulpy, well-coloured stool at a regular hour. If a sufficient dose can be given at night, the morning dose is omitted. Olive-oil used in this way may be continued indefinitely, and when regularity has been perfectly established, the dose may be very gradually diminished till it ceases.

If olive-oil does not succeed, castor-oil may be used in the same way. Find the smallest possible dose, which, given at night or in the morning, secures no more than the proper daily soft movement. Continue this amount till the habit is established, and then, drop by drop, diminish the amount. Other remedies are discussed on p. 244.

When on any occasion it is advisable to empty the lower bowel without delay, as when it may have become blocked with dry hard masses, washing out with tepid water (see p. 592) may be advisable. The lower bowel may also be stimulated by an injection of a tea-spoonful of glycerine, or if thorough emptying is urgent, a mixture of olive-oil 1 to 2 ounces, glycerine 1 to 2 tea-spoonfuls, and warm soapy water 5 to 6 ounces, thoroughly shaken up into an emulsion, and injected by means of an enema syringe, will almost certainly prove effective.

Worms.—These may be often prevented by the careful avoidance of improper kinds of food, and by proper seasoning of the food with salt. They are often introduced with animal food. Great care should, therefore, be exercised in the thorough cooking of all butcher-meat, especially pork, ham, and sausages. They are of three kinds—(1) Tape-worm, passed in pieces like flat white tape, (2) round-worm, and (3) thread-worm. They, and all the symptoms they produce, have been sufficiently described on p. 257 and following pages. It is specially thread-worms that affect children. The best treatment is 1 to 3 grains of santonin given in the morning in cream; and, some hours afterwards, repeated injections of tepid water, in every half-pint of which a table-spoonful of salt has been dissolved, serve to bring them away. Steel-wine or a tonic of some kind should thereafter be given to the child, as well as good food, as debility favours the presence of worms. For the method of injection see p. 592.

Falling of the Bowel.—This may arise from debility, from diarrhœa, or from costiveness owing to straining. It is to be prevented by getting the child into a proper state of health, relieving the costiveness, or checking the diarrhœa. *The bowel must not be allowed to remain down.* To return it, bathe the part gently with cold water, form the fingers into a cone, and, embracing the part, gently push it upwards.

Rupture. — This may occur at the navel within a month or two after the child's birth. It is a swelling which increases with crying or straining. It is caused by a portion of the bowel being forced through the little opening at the navel under the skin. The bowel must be kept within the belly by a small firm pad, secured by a bandage. Rupture in the groin shows a swelling in one or other groin passing downwards and inwards to between the legs. It may exist at birth or be brought on by straining, coughing, or crying. The bowel should be returned at once into the belly, and a proper truss obtained for keeping it constantly in place. Refer to p. 267.

Bed-wetting (*Incontinence of Urine*).—This is a frequent affection, and is due very often to the presence of some irritant in the bowels, such as worms, or about the private parts. Careful search should therefore be made for such a cause. Attention should be given to the diet, to avoid an irritating quality of the urine. Only simple food should be given, pastries and such things being avoided, and simple drink also, milk or water. Little or no fluid should be given the child to drink after 5 p.m., and the child should be roused to pass water about 10 p.m., and once during the night.

Benefit is said sometimes to be obtained by raising the foot of the bed 6 inches or so, on wood blocks, to keep the urine from irritating the neck of the bladder, and it is also recommended that the child should be prevented sleeping on its back by some simple contrivance, such as binding on a thread bobbin. If these measures fail, a doctor should be speedily consulted, lest the habit become confirmed. Mothers should be careful that children are not punished for what may be a weakness rather than a fault. If a doctor is not easily obtainable, the drug that may prove useful is tincture of belladonna. A dose of 4 drops in a tea-spoonful of water may be given about 4 p.m., and another of the same at bed-time. Every second night the dose may be increased by one drop, till ten drops are being given each time. Of course if a small dose is successful there is no need to increase it.

Many cases yield to no treatment, but continue throughout childhood, spontaneously ceasing about the twelfth or fourteenth year.

SPASMODIC AND NERVOUS DISEASES.

Convulsions.—Reference may be made to p. 180 for a general description of convulsions. In children the causes that excite an attack may be put into three classes:

(1) The onset of a febrile disease, such as scarlet fever, pneumonia, &c.

(2) Reflex nervous irritation. Thus the irritation of worms in the bowel may cause them; or the irritation of the bowel by some undigested or indigestible article of food.

(3) Disease of the nervous system.

(1) Under the first class comes a group of causes that are extremely common in children. A grown person, at the commencement of any fever, is usually seized with a shivering-fit, a rigor, as it is called; in children this is usually replaced by a convulsion. If the convulsion be merely the ushering in of an attack of measles, scarlet fever, pneumonia, inflammation of the kidney, &c., the temperature will be found to be raised. The presence of fever should consequently lead to a careful examination of the skin, throat, eyes, &c., for further evidence as to the nature of the commencing fever.

(2) On the other hand, the convulsion may be merely one outward sign of something going on somewhere that is acting as an irritant to the child's nervous system. Now in a child what are the localities where such irritation is most likely to have its seat?

The stomach and bowels are first and foremost among the places from which irritation of the nervous system is liable to be produced. The irritant may be merely ordinary food that has not been properly digested, large pieces of curd, for instance, in the case of the bottle-fed infant. It may be improper food that the child has eaten unknown to parent or nurse, if it is old enough to get about by itself, and is at the stage when it thrusts everything into its mouth that its hands can lay hold of. Thus I have seen pieces of boiled pork with the rind on come away from an infant's bowels, and with their washing away the immediate cessation of fits that had been going on for an hour or two. Similarly, pieces of raw carrot I have seen, and so on. Included also in such causes are worms, and foreign bodies of all kinds. Hard masses of motion retained in the bowel in constipated children act in this respect like foreign bodies.

The teeth is another possible source of irritation that must be mentioned, though teeth cutting their way through the gums are not nearly so common a cause of convulsions as people imagine. When teething seems to be related to the attack, it will usually be found that the child is not otherwise in a very healthy condition, and that its diet is badly managed, and its bowels ill regulated.

The nose and ears, as likely sources of irritation leading to convulsions, must not be overlooked. A pea or bead in nose or ear, or a boil in the ear, may quite easily be the cause of attack after attack, till something directs attention to the place concerned.

From the throat also the irritation may arise.

A partially descended testicle in boys, or a long and adherent foreskin, must not be overlooked in the search for causes.

Inflammation about the urinary passage in girls should be borne in mind.

An attack of convulsions, then, should lead to a careful search, so far as that is possible, to find any indications of any of these regions being the source of the disturbance.

(3) The third class of cases includes such diseases as tubercular meningitis—tumour of the brain, &c.

The above division of causes is rather of practical value than of logical completeness, for its mere statement will indicate to every intelligent person the kind of line on which treatment is likely to be useful.

It will be pretty obvious, for instance, that the attack is not likely to be an extremely serious thing in itself in the first two kinds of cases, but that convulsions due to causes of the third class are of really grave omen. It will also be clear that in the first class of cases any special treatment for the convulsion is scarcely necessary, and that the treatment resolves itself into that of the fever which it is ushering in.

In the second class of cases the urgent thing is to find the source of the irritation, and when it has been found, the means of its removal will be probably apparent.

The moment, however, when the child is actually in a fit is not the time to hunt up and down to discover to what class it belongs, unless one fit is following another with little interval. The immediate question is how to deal with the attack.

But the following procedure will cover the most of the cases, and the explanations just given will make the purpose of that procedure intelligible:—

1. The child should immediately be undressed, and be kept warm in a half-blanket or warm bath-towel.

2. An injection should immediately be prepared and gently passed into the bowel to sweep out all offending material. The best for this purpose is the oil, glycerine, and soapy water, noted on p. 606, but plain tepid water will do if nothing else is available. or plain

warm water with the addition of a table-spoonful of salt.

> The object of the injection must be secured, that is, the complete emptying of the lower bowel.

3. Meantime a warm bath should be prepared. Instead of three or four persons running distractedly about, getting in one another's way, and undoing one another's work, as one has often seen, whenever several people are about, let one prepare the injection, while another prepares the bath.

> There is risk that in the hurry the bath be made too hot. Its temperature should not be above 98° Fahr.

The child should be immersed gently, not plumped in, and should be supported by the hand and arm of the nurse or person holding it, being so placed that the hand is spread over the lower part of the child's back, and the child reclines, as it were, on the arm. The heat of the bath should be maintained by the addition from time to time of a little hot water to the side. The relaxation of the child's rigid muscles, the restoration of its colour, the quieting down of its movements, will indicate improvement. As soon as it has been restored to comfort, and its consciousness is returning, the child should be removed, quickly dried, and, no time being wasted on dressing, it should be loosely wrapped in a warm blanket, and put to bed and lightly covered.

4. In a short time, the attack not having recurred, and the child being quiet, it would be well to administer a full dose of castor-oil to sweep down any offending material from the stomach and upper bowel. But this must be done with caution, and must not be persisted in, if the child resists in any way, lest struggle provoke another fit.

5. If these measures have all proved fruitless, or have only procured brief intervals of quiet, a solution of bromide of potassium should be injected into the bowel. The dose for an infant is 5 grains dissolved in one table-spoonful of tepid water, and it should be injected slowly by means of a glass syringe, no air being introduced. A child one year old may have 10 grains, and the dose may be repeated every hour if necessary for four doses. With older children, rather than give larger doses, one may repeat them oftener, every half-hour till four doses have been given. The addition to each injection of one grain of hydrate of chloral greatly increases the effect of the bromide, but it is too powerful a drug to be administered by an unqualified person, except in grave emergency, when no medical man is available.

6. The application of cold to the head, or an ice cap (pp. 337, 338), and wrapping round feet and legs a piece of flannel, wrung out of warm mustard and water (a tea-spoonful of mustard to a tumbler of warm—not hot—water), will help to maintain the soothing effect of the bath.

It is when the immediate urgency is over that the search for sources of irritation should be quietly made, should the material brought away from the bowel not have revealed it.

Night-terrors, in which a child starts up from sleep shrieking and in a state of extreme terror, are commonly caused by irritation through undigested or indigestible food. Care in the management of food, already so often advised, and attention to the bowels, will prevent their recurrence. If this is insufficient a dose of 5 grains bromide of potassium with 2 of antipyrin may be given the child at bed-time in a table-spoonful of water.

Spasm at the head of the Windpipe—Child-crowing—False Croup.—The child is suddenly seized, and frequently during sleep, with spasm that prevents the entrance of air to the lungs; the face becomes swollen, red, and then bluish, owing to the great difficulty of breathing. The child is extremely agitated, and there seems a tendency to convulsions. In a short time the spasm yields, the air rushes in with a long crowing noise, and the child falls back pale and exhausted, and becomes in a short time composed as if nothing had happened. The fit may recur, and may, if prolonged, cause death by suffocation. It is a nervous disease, and occurs owing to nervous irritability. The irritation may be from teething, or the child may be so excitable that a slight fright may occasion it.

Dash cold water over the child's chest. A hot foot-bath with mustard, or a warm bath for the whole body, is also useful. While the child is in the fit, forcibly open the mouth and pull forward the tongue, grasping it by a handkerchief between fingers and thumb. As a preventive, bromide of potassium, in doses from 2 to 5 grains, with 5 drops spirits of ether or tincture of valerian, is useful. Examine the teeth and ears, and watch the bowels, so that any cause of irritation may be removed.

St. Vitus' Dance or Chorea is discussed on p. 182.

Water-in-the-Head is considered on pp. 155 and 156.

Paralysis as it sometimes attacks children is discussed on p. 179.

Fevers and other Infectious Diseases.

These have already been discussed elsewhere.

Scarlet Fever, - - -	Refer to p.	519
Measles and German Measles,	,,	521
Typhus Fever, - - -	,,	531
Typhoid Fever. - - -	,,	532
Small-pox, - - - -	,,	523
Chicken-pox, - - - -	,,	530
Whooping-Cough, - - -	,,	537
Diphtheria and Croup, - -	,,	538
Mumps, - - - - - -	,,	213

SKIN DISEASES.

Skin diseases have been sufficiently discussed in Section XXI., p. 417 and following pages. In general they are to be treated by dieting, attention to the bowels, and frequent use of the bath and carbolic acid or tar soap.

Nettle-rash.—See p. 420.

Red-gum Rash.—See LICHEN, p. 427.

Tooth-rash is similar to the above, and to be treated in the same way.

Scald-head. See ECZEMA, p. 425.—It may, however, be noted here regarding this skin affection that it is attended by the formation of "watery heads," which leak, are very itchy, and give rise to yellowish-green scabs. It occurs often on the head, ears, nose, &c. The scabs should be got rid of by warm poultices of soft mashed turnips. Bathing with warm water to which a pinch of soda has been added will relieve the itching. When the scabs have been *completely* removed, the yellow precipitate ointment mentioned on p. 426 should be used; or, better still, a new ointment called chrisma sulphur. The child's system should be strengthened by cod-liver oil, chemical food, &c.

Rickets.

Refer to p. 71.

Bow-legs are to be prevented by treatment similar to that for rickets.

Accidents.

Scalds and Burns.—Remove the clothing as carefully as possible. Put the child in bed and see that it is warm. Arrange a box, wire-guard, or other similar contrivance over the burned part to keep off contact with bed-clothes. Under such an arrangement the injured part is to be kept free from cloths, cotton or other material, while at the same time kept warm. Paint the part, by means of a feather, with a mixture of equal parts of raw linseed-oil and lime-water. This is very cool and soothing if freely and frequently applied. In every house a bottle of this mixture should be kept, and quickly painted on the slightest burn or scald. Should a child's clothing take fire, throw over it a shawl, blanket, or other woollen article, and so smother out the fire. If the mouth or throat have been severely scalded, let ice be sucked till medical aid is obtained.

Wounds and Bruises.—If the wound is clean cut, bathe with cold water. This, with gentle but firm pressure, will stop bleeding. Remove any dirt or other foreign matter; bring the edges together accurately and keep them there with plaster and a bandage. To bruises apply cold-water cloths *if it is attended to at once.* This prevents swelling of the part. Any swelling, blueness, &c., which may result can afterwards be got rid of by aid of warm-water cloths. For wounds and bruises a recent remedy is very valuable, the extract of witch-hazel. It is sold in America as Pond's extract; and in Great Britain a special preparation is sold under the name Hazeline.

Sprains.—Rest is the main treatment. If the sprain receives immediate attention, surround the parts with cloths wrung out of iced water. This keeps down the swelling and relieves pain. Later, or if the cold applications are disliked, apply warm cloths. When all pain and inflammation have quite passed away, *but not till then*, rubbing with or without liniment will help to restore the use of the part.

Falls on the Head should receive careful attention. The child should be put to bed and keep quiet for the day. He should also receive a large dose of purgative medicine, castor-oil or syrup of senna. Cold cloths should be kept to the head and only milk diet allowed. If the child is cold, warm bottles should be applied to the lower limbs, and the body gently rubbed, *but no stimulants of any kind should be given.*

Choking.—If a piece of food has stuck in the throat, support the child's head by the left arm, open the mouth with the handle of a spoon or a piece of wood, pass in the forefinger well to one side of the mouth against the cheek and push it right back into the throat. By sweeping the finger round, the mass may be hooked out.

SECTION XXVIII.

HEALTHY WOMANHOOD: MENSTRUATION, PREGNANCY, AND LABOUR.

- **The Dress of Girls:**
  - *The Conditions of Healthy Dress;*
  - *The Common Errors in Girls' Dress*—The evils of stays and the deformities they produce;
  - *Suggestions as to Healthy Clothing.*
- **The Education of Girls:**
  - *Higher and University Training*—Opinions of various authorities in England, America, and France.
- **The Female Generative Organs:**
  - *The External Genital Organs.*
  - *The Womb* (uterus), *Fallopian Tubes*, and *Ovaries.*
- **Menstruation** (*The Monthly Illness*):
  - *Time of Appearance and Symptoms;*
  - *The Change of Life;*
  - *Vicarious Menstruation;*
  - *The Management of the Monthly Illness.*
- **Pregnancy and its Management:**
  - *Conception*—The male and female elements in conception;
  - *The Growth of the Offspring in the Womb*—The formation of membranes and after-birth (*placenta*)—Progress of growth at different months—The size and weight of the child at birth;
  - *The Duration of Pregnancy*—Probable Date of Confinement.
  - *Signs of Pregnancy*—Stoppage of Monthly Illness—Morning Sickness—Changes in the Breasts—Enlargement of Abdomen—Movements of Child—Sounds of Child's Heart.
  - *The Management of Pregnancy*—Food—Clothing—Exercise—Bathing—The Breasts—Medicine.
- **Preparations for Confinement:**
  - *The Nurse;*
  - *The Lying-in Room;*
  - *The Bed;*
  - *Special Bed Requirements*—Accouchement Sets—Gamgee—Sponges.
  - *Utensils for the Lying-in Room;*
  - *Instruments needed by the Nurse*—Enema Syringe—Catheter—Thermometer—Douche;
  - *Toilet Articles in the Lying-in Room;*
  - *Antiseptics*—Corrosive Sublimate—Carbolic Acid—Lysol—Creolin—Boric Acid—Izal—Condy's Fluid.
  - *The Mother's Preparations;*
  - *The Nurse's Preparations.*
- **Labour and its Management:**
  - *The Stages of Natural Labour*—The first, second, and third stages;
  - *The Duration of Labour;*
  - *The Position of the Child in Labour*—The attitude, presentation, and position of the Child;
  - *The Management of Labour;*
  - *Symptoms of Labour;*
  - *The Management of the Various Stages of Labour;*
  - *The Treatment of the Newly-born Child;*
  - *The Treatment of the Mother after Delivery;*
  - *After-pains;*
  - *The Discharge.*
- **The Practice of Midwifery by Midwives in England and Wales:**
  - *Rules of the Central Midwives' Board.*

HEALTHY WOMANHOOD.

In Section XXVI. statistics have been given showing the rate of bodily growth in weight and height of both sexes. From these tables also it will be observed that in girls, between the ages of eleven and thirteen, increase in height and weight becomes more rapid than at any other period of life, while growth begins to diminish at thirteen years of age, and at the age of sixteen it begins to cease. A similar occurrence is evident in the case of boys, but several years later. This comparatively sudden falling off in physical growth is coincident with the attainment of the period of puberty. **Puberty** is derived from a Latin word, *puber*, signifying of ripe age, or adult. The age of puberty is the period when the development of certain organs, devoted to the function of reproduction, so advances that the person becomes capable of discharging that function. As this period arrives, the energies, formerly devoted mainly to the building up of the general bodily structure, become largely diverted, and the increase in height and weight is thus rapidly diminished. It is just previous to the arrival of this period that the marked increase in stature and weight occurs. Both these occurrences are indications of critical stages in the life-history of the individual. The period before puberty, the **prepuberic period** as it is called, is a time when the nutritive processes of the body are in a condition of high activity, as is sufficiently indicated by rapid growth; and the equally rapid falling off in growth is also indicative of profound constitutional changes. Both are periods which make exceptional demands on the bodily powers, and which are, therefore, attended by risks of their own, specially so in girls, in whom the changes connected with this stage of life are more rapid than in boys. It is a time of instability, a time when all the powers of body and of mind are sensitive to slight influences and easily overbalanced. It will be well, therefore, to indicate briefly what suggestions physiology has to make to parents and guardians to aid them in their appropriate guidance of girls under their charge. First of all, and in general, reference may be made to section XXVI, where the advisability is urged of observing, at periodical times, the rate of growth in height, and the relation of height to weight, as indicative of the condition of bodily health and vigour. Any marked variation from the standard there given should lead to more detailed examination of the state of health, and, if need seem, to an examination by the family physician to ensure that nothing is wrong. In this respect girls and boys are to be treated in the same way. Some special remarks are called for, however, in regard to the dress and education of girls.

THE DRESS OF GIRLS.

Conditions of Healthy Dress.—Strictly speaking there is only one purpose of dress, and that is to maintain the whole body at an appropriate and equal degree of heat. That main purpose being fulfilled, there are various secondary conditions to be kept in view. The dress ought to be light, so that the bodily energy is not taxed to carry about an unnecessary weight, and it ought to be so adapted to the body as to leave unhampered all the natural movements of the body. This second condition implies not only that the movements of the limbs shall not be restrained, but also that such movements as those of breathing shall in no way be impeded, and that, as another example, no part of the clothing shall so constrict a part as to interfere with the natural flow of blood in it. The main purpose of clothing being fulfilled in accordance with these conditions, it is time enough to consider how the dress can be made graceful or becoming.

Common Errors in Girls' Dress.—It is easy to point out how the ordinary dress of women and girls breaks the above rules. It is not arranged so as to keep the whole body equally warm. There is more clothing over the hips than on any other part of the body. All the underclothing leaves the neck and shoulders practically bare, and when they are covered it is only by the bodice of the dress. Unless the sleeves are tight-fitting, the arm is really exposed up to the elbows, while, owing to the looseness of the skirts, the legs from the knee downwards are insufficiently protected. If the clothing is improperly distributed as regards warmth, it is as apparently improperly distributed for purposes of easy carriage. The heaviest portion of it hangs from the waist, and the weight itself necessitates the drawing of the garments tight that they may be properly supported, so that the one evil leads to another. On the other hand, garments dependent from the shoulders are easily borne, and entail no undesirable constriction round the waist. A third point in which female dress is strikingly at variance with the conditions of healthy dress is in its undue weight. It will be admitted that the total weight of the clothing is out of all proportion to the degree of warmth that it is required to maintain, and that if only warmth and protection are to be taken into account, much of it is superfluous. Thus the weight is not only badly arranged for easy carriage, but it is excessive in amount. This becomes a very important question in relation to exercise. The addition of one or two pounds weight of needless clothing may seem a trifling affair, but when one considers the bodily energy expended in carrying these few pounds a distance of a few miles, it is easily seen that that slight extra weight may be indeed a serious burden, even in the ordinary movements of locomotion, and becomes an unconscious hindrance to free and vigorous exercise. Custom prevents this being fully appreciated, but women themselves know well how weighed down they feel when walking with clothing wet with rain. The increase in weight is not much, but it is felt as a load, just because it is more than they are accustomed to. Perhaps female dress does not err, from a healthy standard, more grievously than by the undue restriction of movement which it enforces. It is needless to say that the movements of the legs are very limited, and that running or jumping would be accomplished with difficulty. Tight sleeves seriously press on parts, especially at the arm-pits, and impede the circulation in the arm; garters, by their pressure below the knee, offer a very considerable obstacle to the return of blood in the veins from the parts below, and directly encourage the production of dilated veins with all their attendant evils.

The Evils of Stays, and the deformities they produce.—These mistakes are as nothing to that of tight-lacing, and the evils they produce are small in comparison with those that attend this larger and greatest of all evils of feminine dress. The real effects of tight-lacing ought to be thoroughly considered. First of all, it undoubtedly impedes the full expansion of the lungs. In the section on Respiration it is explained (p. 346) that the act of breathing consists of an expansion of the chest in every direction; the cavity of the chest enlarges and air rushes in to fill up the lungs, and so occupy the increased space; thereafter the chest returns to its usual size, and air is thus expelled to permit of a diminution in the expansion of the lungs to fit the diminished space. The chief way in which the chest cavity enlarges is by the descent of the diaphragm, which is at once the floor of that cavity and the roof of the cavity of the abdomen or belly. When the diaphragm descends it does so at the expense of the belly cavity, on whose space it encroaches, and to make additional room the front and side walls of the abdomen bulge outwards. Now if the waist and part of the chest are encircled by a tightly drawn and, by the agency of steel, practically unyielding structure like stays, this movement of the abdominal walls cannot be developed, the descent of the diaphragm is arrested, and expansion of the chest in this direction becomes difficult. To compensate for this, enlargement must take place by exaggerated raising and widening of the upper part of the chest through movements of the ribs. The lower part of the chest is restricted in movement, and in the upper part the movement is overdone. The lungs are thus insufficiently and improperly inflated, in their upper portions having to bear an unnecessary strain, and their lower portions being seldom properly distended at all. Moreover, the constant pressure exerted by the stays forces inwards the lower ribs, and specially the last two on each side, the floating ribs, which have no attachment in front, and forces in to some extent also the lower ribs next to them, so that the shape of the chest becomes actually altered, and instead of being broad and expanded low down, it is narrowed and drawn in. All this means diminished breathing-space, enfeebled breathing-power, and its indirect consequences it is difficult to estimate. But more than this: the pressure exerted by tight stays seriously alters the proper positions of the various organs in the abdomen. It is difficult to state with any accuracy how many different kinds of disturbance of a good state of health may arise in this way. The normal circumference of the waist ought to be from 25 to 27 inches. Under the influence of lacing this may be reduced to 20 or 22 inches, and even less, 16 inches being considered by some fashionable dressmakers the goal to be reached. Now all this constriction takes place at the expense of the space within the abdomen, and partly within the chest; for, as has been stated, the lower ribs are easily compressed from the slight nature of their attachments in front.

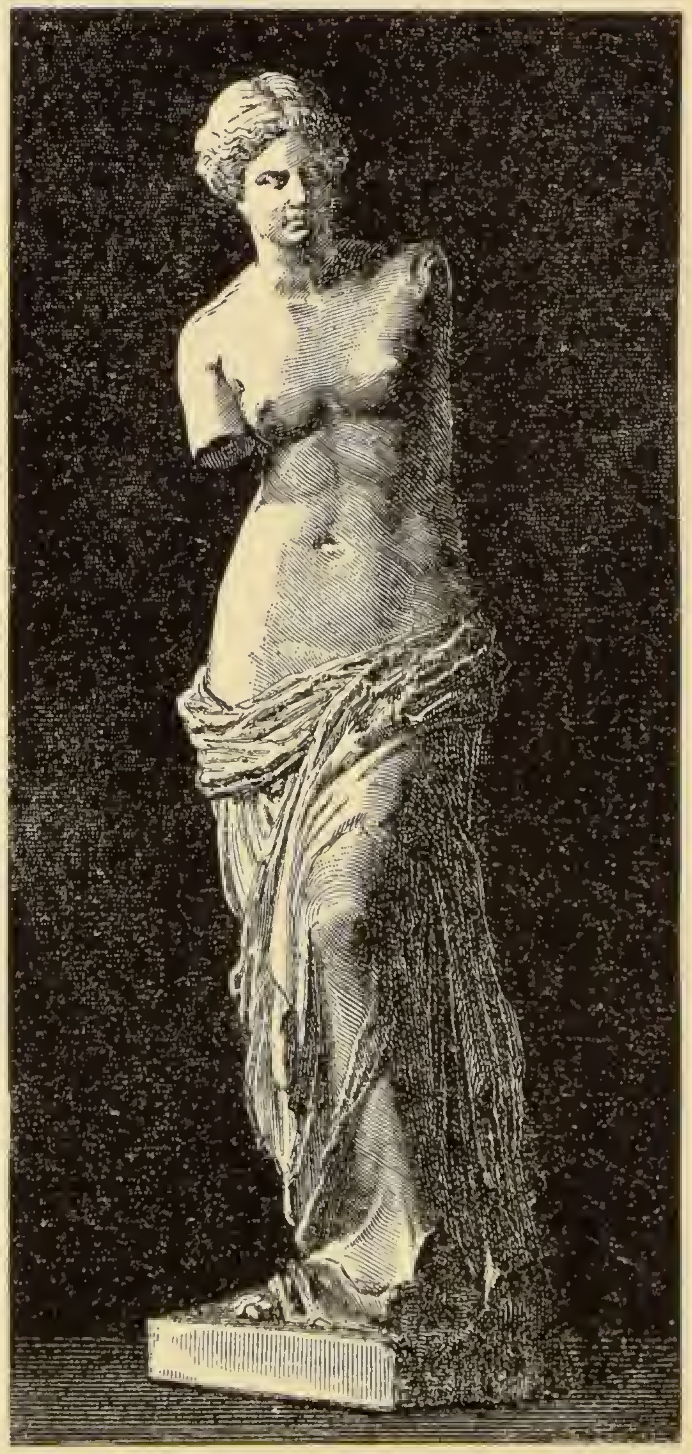


Fig. 204.—The Venus of Melos, showing the natural female form.

Now in the ordinary condition every inch of space is occupied by the various organs, and the compression can only be exercised at their expense. The stomach, bowels, and liver will be directly affected, pressed together to some extent, and also to some degree forced upwards or downwards. This undue pressure tends to prevent full growth of the parts, and, even if they have previously been fully developed, some degree of wasting (atrophy) or shrinking

After death the liver on examination has been seen to bear permanent marks of the ribs pressed on it by tight lacing. For even though the pressure is relaxed every time the corsets are removed, the continuous daily recurrence of the compression gradually establishes a permanent state of constriction, so that the parts do not return to their normal size on removal of the pressing force. It is undoubted that indigestion, disturbances of the liver and bowels—even ulceration of the stomach—have been the results of the persistent practice of wearing tight stays. Besides being themselves directly affected in this way, these organs, according to the amount of displacement they are bound to experience, alter the relations of others. Pressed upwards, they encroach on the space that ought to belong to heart and lungs, breathing is disturbed, and the natural action of the heart interfered with. Palpitation, faintness, and many other heart symptoms may be the direct consequences. Then the pressure exerted downwards inconveniences the bladder, and is a very frequent cause of altered positions and disordered functions of the special female organs. Displacements of the womb, with all the manifold influences they may have on the monthly illness, are recognized as often produced by such a cause as this. While such evils as these result from the practice, what benefits, it may be asked, are supposed to be derived from it? It can hardly now be maintained that the "taper waist" is desirable from its beauty. Any standard of beauty as regards human form is derived rather from that which appears to be most perfect in its development and most natural in its outlines. Greek statuary shows with perfect distinctness the views held by the ancients on the subject. The Venus of Melos shows the natural outline of the waist, and is a model of what its sculptor must have esteemed an ideal of beauty. The wood-cut in the text, taken from a photograph, while it sufficiently indicates the outline, cannot suggest the dignity and grace which the statue itself so wonderfully exhibits. Let anyone compare this outline with that given to the female form in any fashion-plate, and there ought not to be much difficulty in admitting that the "taper waist" is, strictly speaking, a deformity artificially produced. It is urged, however, that stays are necessary to distribute the weight of the clothes and to give some support to the back. As to distributing the weight of the clothes, it has been already indicated that the suspension of so many clothes from the waist, which is supposed to necessitate the use of the corset, is itself a grave mistake, and there can be no doubt that the clothes can be so adjusted from the shoulders as to render any such artifice as stays unnecessary. As to the need of supporting the back, that is rather the effect than the cause of stays. For the fashion in which, even from infancy, children are hedged in, from the hips to the arm-pits, by a more or less stiff wall, is undoubtedly productive of feeble development and deficient vigour of the great muscles which run right down the back on each side of the back-bone. It is one of the first laws of growth that moderate and regular exercise of a part of the body strengthens that part; in short, that its strength is in proportion to the use that is made of it, and that, on the other hand, disuse of a part inevitably tends to weakness and wasting. Now the swathing to which infants and young children are subjected so restrains the activities of the muscles of the trunk that proper exercise of them is impossible, and the corsets of later years even more effectually impede their activities. It is therefore the stays that render the back weak, not the weakness of the back that renders the stays necessary.

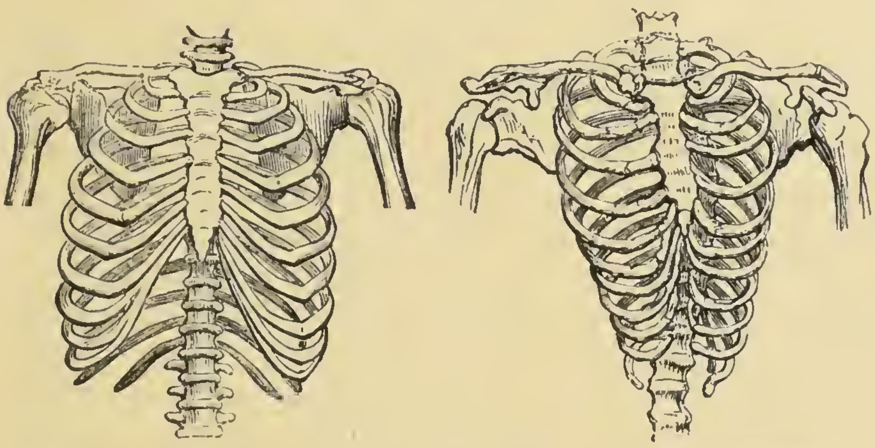


Fig. 205.—The Bony Walls of the Chest. That to the left shows the natural position, that to the right the deformed position due to tight lacing.

Suggestions as to Healthy Clothing. — These are some general criticisms, meant to point out the errors, from a point of view of health, in the general character of woman's dress. It is only women themselves, however, who can successfully carry out any reform in this direction. Fashion is too imperious to bow to the authority even of health, and, probably, the necessary reforms will not al be carried out till the time arrives when health becomes fashionable. But even though the outward appearance of woman's clothing must be regulated, not by a question of comfort and physical well-being, but mainly by the whim and caprice of the rulers of fashion, every woman has it in her power, while submitting to the fashion-makers, to adapt her clothing in order that it may fulfil more thoroughly than it usually does its obvious purposes. That is to say, if a woman must conform to what other people wear in the matter of a cloak or a jacket, a bodice and skirt, and if she must cut her bodice in accordance with the mood of the times, and adorn her skirt with furbelows or frills as the newest style directs, she can at least exercise her own will as to the nature of that portion of her clothing which is not meant to be visible. Underclothing consistent with health is not a very elaborate affair. There ought to be a garment next the skin, made of wool or flannel, shaped to fit easily. A knitted "suit" would probably be the most useful. It should reach up to the neck, fitting it as close as is comfortable, and ought to be provided with sleeves down past the elbow, also easy fitting. The lower part of this combination garment would extend below the knee. Over this, linen garments might be put on according to the pleasure of the wearer, but they ought not to be made with that exuberance of material, both in length and breadth, which is customary, and which necessitates so many creases and folds and doublings. Thus a chemise might be made with some respect to the length and circumference of the body it was designed to clothe. Any petticoat ought not to be simply fastened round the waist, but ought to be suspended by something like braces from the shoulders, or by buttoning on to a light bodice. But if any additional *heavy* underclothing is required, for more warmth, it ought to approach as nearly as possible to a divided garment that will cover each leg separately. Such *light* petticoats as are worn for appearance need, of course, no such division. Now it cannot be said that underclothing of such description as this demands anything in the nature of stays, for there is no great weight in it, and what weight there is is borne from the shoulder. Stays, therefore, ought to be entirely discarded as an article of dress, of whatever description they may be, for children, girls, and young women. It may be admitted, however, that nursing mothers require more support to the breasts than ordinary clothing supplies, and that for them some form of corset is required. But this ought rather to be in the shape of a bodice made of stouter material than usual, and such a bodice could be readily made without the steel bands and other stiff structures of which ordinary corsets chiefly consist. Women who have naturally more largely developed breasts than usual could adopt such a form of support as would easily meet the requirements of comfort and appearance. This healthy form of underclothing that has been suggested, if it were adopted, need not interfere with the wearing of a dress and its bodice made according to the requirements of the times, and thus health and fashion would each have a due amount of regard paid to them.

As regards covering for the feet and legs, woollen stockings ought to be worn, but the usual method of securing them by garters round the knee is highly injurious. Any garter to be sufficiently tight for this purpose must press on the veins of the surface, and thus impede the circulation in the skin. This obstacle to the free upward flow of blood from the foot and leg causes an accumulation of blood in the veins; the pressure of blood becomes so increased that the walls of the veins are apt to yield, especially in older persons, and varicose veins or a swollen and inflamed condition of the skin are in time the results. They often lead also to a feeling of weariness and pain, just owing to the interference with the circulation. The stockings ought, therefore, to be secured by suspenders connected with the shoulder-brace or bodice. The form boots and shoes ought to take is considered under HYGIENE.

It cannot be too strongly impressed upon mothers, and those who have the charge of girls, that attention ought to be paid to the clothing of girls, to ensure that the purposes of clothing are carried out, and are not carried out in any way that is inconsistent with the highest degree of health and healthy growth. Many of the most serious evils of a woman's life, and an innumerable number of the minor ailments that seem little in themselves, but nevertheless among them make the difference between an active, bright, and energetic woman and an ailing and feeble woman, are the result of mistaken notions in clothing of which the woman was the victim during the period of childhood and youth. Grown-up women may dress themselves as they please, and may violate the laws of health, if they choose to sacrifice themselves to foolish notions of what is desirable in female form, but they are not entitled to humour their fancies in the dress of their children, if the methods they adopt are likely to hinder the healthy growth of the children, or tend even indirectly to encourage feebleness.

THE EDUCATION OF GIRLS.

Higher and University Training. — It used to be a common subject of discussion whether women are intellectually inferior to men, and it was also commonly concluded that they are. Whether that be so or not, it is a fact that woman was for many centuries kept in subjection, and that indeed it was not till the advent of Christianity that woman was called to occupy her position as not the inferior but the complement of man. If there is any truth in heredity, this long-continued subjection must be taken into account, and the suggestion of the old question that girls should not receive so complete an education as boys, because they are unfit for it, must be set aside.

Without attempting a logical definition, we may say that education has as its objects the leading out or developing of all the powers of mind and body; and even if it were admitted that woman is mentally inferior to man, that is only an additional reason for more careful, and complete, and well-adapted training. Linked with man in life's work, and one with him in destiny, why should woman be less carefully prepared for the duties of life or less fitted for its issues? Accordingly, now as complete an education is being gradually extended to girls as is given to boys, nor is a university education now denied to them.

Opinions of Various Authorities in England, America, and France. — Although sufficient time has hardly elapsed, since this movement began its full swing, to enable one to estimate accurately its effects, nevertheless a very considerable body of testimony is put forward to show that girls are not only fitted intellectually for the highest developments of education, but are not necessarily injured physically. Thus Mrs. Henry Sidgwick, speaking of her experience at Newnham and Girton Colleges at Cambridge, says "the experience of Girton and Newnham certainly shows that the danger need not be alarming. The actual number of women who even temporarily break down at Cambridge from the effects of work is exceedingly small in proportion to the whole; and as for the average health of the hard-working students, it is little to say that it would compare very favourably with that of girls who are laboriously devoting themselves to the pursuit of amusement. I think it may be asserted that it would compare favourably with the average health of young women generally in the class from which our students are drawn. In fact, overwork is an evil to which attention ought to be continually given, not so much because the danger of it is great, as because it is to a large extent preventible. A delicate woman may go, and frequently has gone, through the course of training for an honour examination without any injury to her health, and even with positive gain to it, from steady and not excessive work, with power, to a great extent, to chose her own days and hours for it; but even a strong one is liable to make herself ill unless she will observe the ordinary common-sense rules of health as to sleep, food, exercise, recreation, and other things."

Miss Freeman, President of Wellesley College, Massachusetts, judging from the experience of three colleges for women in the Eastern States of America, the Vassar, Wellesley, and Smith Colleges, where in 1883 there were more than 1000 women students, says the results have been "so manifestly good that they would go on, greatly trusting that in educating women's heads they would not hurt their hearts or ruin their constitutions."

Mrs. Richards of Vassar College offers proof of the possibility of giving girls a complete university education free from danger to health, in the shape of statistics concerning a large number of women who had studied and graduated at first-class institutions, and who had passed out of them from five to fifteen years before the date of inquiry. As a result of the inquiry "physicians had acknowledged that they were surprised at the comparatively good health of the educated women of America as shown by these statistics." According to Mrs. Richards, "experience had shown that if a girl was well cared for from twelve to eighteen, then went to college from eighteen to twenty-two, during that period there would be no trouble whatever." She hoped that those who had the control of education in this country (England) would look closely into that matter. It was, of course, very difficult to keep acquainted with those who had left college, but if some kind of record could be kept of their subsequent health, that would be the best answer which could be given as to the danger of the physical effect of education upon girls.

In France there is a magnificent college at

Sèvres for women, the École Normale Secondaire Supérieure, concerning which Professor Darmesteter says "the system for the higher education of women had already produced good results, and he trusted that it was opening up a new era in the education of women." Similar testimony comes from Germany.

There is, of course, another side to the question. The modern objections to an education for girls as complete as that for boys centre round the opinion that such education unfits girls, by the nervous strain to which they are subjected, for their duties in life as wives and mothers. There is evidence in support of that opinion. Professor Loomis, of Yale College, regarding the increasing physical deterioration of American girls, says "the cry to our older colleges and time-honoured universities is: Open your doors that the fairer part of creation may enter and join in the mental toil and tournament! God save our American people from such a misfortune!" This, however, it is right to say, was the opinion of Professor Loomis at a much earlier period than the testimony in favour of university education for girls already given. Dr. Withers Moore of Brighton gave his address as President of the British Medical Association in 1886, on the subject of the higher education of women. He asks: "Is it for the good of the human race, considered as progressive, that women should be trained and admitted to compete with men in the ways and walks of life, from which heretofore (as unsuited to their sex) they have been excluded by feeling and usage, and largely, indeed, by actual legislation?" He answers that "it is not for the good of the human race, considered as progressive, that women should be freed from the restraints which law and custom have imposed upon them, and should receive an education intended to prepare them for the exercise of brain power in competition with men. And I think thus," he continues, "because I am persuaded that neither the preliminary training for such competition work, nor the subsequent practice of it in the actual strife and struggle for existence, can fail to have upon women the effect of more or less (and rather more than less) indisposing them towards, and incapacitating them for, their own proper function—for performing the part, I mean—which (as the issue of the original differentiation of the sexes) Nature has assigned to them in the maintenance and progressive improvement of the species. . . . This 'higher education' will hinder those who would have been the best mothers from being mothers at all, or, if it does not hinder them, more or less it will spoil them." Dr. Moore cites in support of his opinion the views of Herbert Spencer, Dr. Matthews Duncan, Sir Benjamin Brodie, the late Dr. Edward H. Clarke (U.S.A.), Dr. Emmet of America, Mr. Lawson Tait of Birmingham, and others, mostly specialists in diseases of women.

The general strain of these opinions will be sufficiently indicated by the following from the late Dr. Thorburn, of Owens College, Manchester: "The struggle for existence on the part of single women, and the capacity of a few of their number to ignore, with safety, the physiological difficulties of the majority, are demanding opportunities for education and its honourable as well as valuable distinctions, which cannot and ought not to be refused. Unfortunately, however, up to this time no means have been found which will reconcile this with the physiological necessity for intermittent work by the one sex. It becomes, therefore, the duty of every honest physician to make no secret of the mischief which must inevitably accrue, not only to many of our young women, but to our whole population, if the distinction of sex be disregarded."

If, however, we carefully consider the burden of the objections raised to the full education of girls, and the recent developments of female education in England and America, some way out of the maze created by these differences of authority seems possible. We have to consider that many women find the necessity of earning their livelihood in occupations requiring careful education and a large amount of mental toil, and we find a large and daily increasing number of women who value the highest education, not for what it will bring, but for its own sake. The claims of neither of these can be disregarded. Up to the age of twelve years there is no reason why girls should not receive an education equal to, if not identical with, that given to boys. It is after that age that difficulties arise due to the special circumstances of sex. It is about that age that special developments take place in the training of boys dependent upon their intended course through life. If they mean to go in for commercial pursuits, the education is moulded in accordance with that intention; if for professional life, they go on to training preliminary to the universities. If they are boys who, by reason of their position, can afford to pursue an education whose immediate object is culture, and whose ulterior object may be determined at a much later period, according merely to fancy or inclination, the higher education of the secondary school and the university is proceeded with. This age is also the time when, in the case of girls, the special circumstances dependent on her sex require to be taken into consideration. The Americans seem to find that if, after that age, whatever may have been the system adopted before it, the education of girls is directed with special regard to her physiological necessities, that is with regard to the monthly changes which periodically occur, all danger may be averted. This almost implies that girls be taught, after that age, in secondary schools set apart for themselves, where they do not enter into competition with boys, and where, on that account, a periodical relaxation of studies may be permitted to occur without throwing one set of pupils out of line with another in rate of study. Still further to diminish all tendency to overstraining, the best American opinion seems to indicate the advisability of abolishing competitive work and examination among girls, and it is found that the love of work itself supplies sufficient stimulus to requisite exertion, that, even when competition is not engaged in, the eager desire for learning requires careful watching to hold it sufficiently in check. Similarly, colleges for women only, where like care and supervision are exercised, seem preferable to mixed colleges where an unhealthy straining to excel is almost certain to exist. Such a regulation of study, in accordance with girls' physiological requirements, is only possible in an institution exclusively devoted to girls.

Overpressure in education has as pernicious an effect on boys as it has on girls. That evil is got rid of by proper regulation of study, and, along with care in diet, &c., by means of a due amount of exercise and recreation. This general rule is applicable to girls as well as to boys. The special objection in the case of girls is that the *continuous* mental application is not consistent with the special demands made upon a girl's energies at regularly returning periods connected with her peculiar functions. That objection, we believe, is met by such provisions as have been already indicated, which, however, as we have already said, can only be properly made in secondary schools and in colleges devoted exclusively to the female sex, and regulated with due regard to these functional peculiarities. In short, the objections that have been urged against the according of the highest education to girls do not strictly lie against the education itself, but against the system on which it has been conducted. The arguments are not logically against giving the same education to girls as to boys, but against giving that education *in the same way*. We believe the difference in the testimony that came from America at an early period in the movement for higher education, which was not in its favour, and the later testimony, when better methods had been devised, and which was in its favour, is simply due to that fact that the necessity for periodical relaxation had not been recognized at the early period, and was fully realized at the later. Thus one teacher, in giving evidence before the State Board of Massachusetts in 1874, said: "*At certain periods* I think that study with girls should wholly cease for some days. I refer to girls from twelve to twenty years of age. Anyone who has taught boys and girls—in separate schools, I mean—must have noticed the greater proportionate irregularity of attendance of the latter, and as a parent he would know the reason and the necessity of cessation from work." Another says: "Could the custom of keeping girls between the ages of thirteen and nineteen out of school and at moderate rest *during certain periods* become established among us, a certain number might suffer restraint not absolutely demanded, but the general result would be an incalculable gain to the health, present and prospective, of the inhabitants of this commonwealth." Dr. da Costa, of New York, maintains that "common sense and the teachings of physiology point in the direction of lessening, as far as practicable, work *at a time when the whole system is depressed*." Dr. Cohran of the New York State Normal School has been "compelled to the conclusion that the sexes cannot be educated *on the same system* with advantage, and that the physical disadvantages under which the female labours render it necessary that a system be devised so elastic, with so much optional work, that the female may rest, at least comparatively, *as the occasion requires*." Those parts of the opinions have been printed in italics, which show clearly that the objections taken are not to the higher education in itself, but to the difficulty of reconciling it with the periodical change in women, and that difficulty later methods have to a large extent overcome.

The conclusion of the whole matter seems to be, let girls have the same education as boys, and along with boys, if need be, up to the age of twelve years, overpressure being carefully avoided in the case of one as in the case of the other, a due amount of recreation and exercise being daily insisted on; after that age deny not to girls secondary and university education, but let it be conducted in institutions restricted to them, but as fully equipped and conducted by as able teachers and professors as similar institutions for boys, where, however, periodical variations in the amount and degree of mental effort can be arranged for in accordance with the periodical variations in the amount of energy than can be devoted to nervous activity, with proper regard to other requirements. By such means the world will be blessed with wise and cultured women, and will not be without vigorous wives and mothers, not less capable of the highest duties of womanhood because to the sweet instincts of nature they add the rich treasures of a cultured mind.

THE FEMALE GENERATIVE ORGANS.

At the age of from thirteen to sixteen years, in temperate climates, changes occur in girls which indicate that a stage has been reached in the development of special organs, and that the girl has become capable of her peculiar functions. The main change is the occurrence of a discharge from the genital organs, which, because of its recurring at regular intervals of twenty-eight days, or one lunar month, has been called the "monthly illness." Before considering what the discharge means, it will be necessary briefly to describe the organs concerned.

The External Genital Organs of the female consist of two lips or folds of skin surrounding a passage—**the vagina**—which leads inwards. The external surface of these lips is covered with hair, and they are called the **labia majora**. Just above where these two folds meet in front, and immediately over the pubic bone (see p. 63), is a raised portion of skin covered with hair, raised because of a cushion of fat under it, and called the **mons veneris**. Within the labia majora, and protected by them, are two folds of delicate skin, uniting in front to form an arch and thinning away as they pass backwards along the side of the vaginal opening. These are the **labia minora**, or **nymphæ**. Just before the labia minora join in front to form the top of the arch, each splits into two divisions, so that the very top of the arch is double, and in the triangular space thus formed is a very sensitive part called the **clitoris**. Between the sides of the arch, formed by the labia minora, and bounded by the clitoris, forming the top of the arch in front, and the orifice of the vagina behind, is a triangular space, called the vestibule. It is covered by smooth mucous membrane, and in the centre of it is the entrance of the urinary passage—the **meatus urinarius**—that leads to the bladder. This opening is slightly raised above the surface, lies exactly in the middle line, and about 1 inch farther back than the sensitive clitoris, and slightly farther in. The urinary passage passes for a short distance in a slightly curved direction, and then up to the bladder, and is barely 2 inches long. All these parts—mons veneris, labia majora and minora, clitoris, vestibule, urinary meatus, and vaginal orifice are included in the term **vulvæ** or **pudenda**.

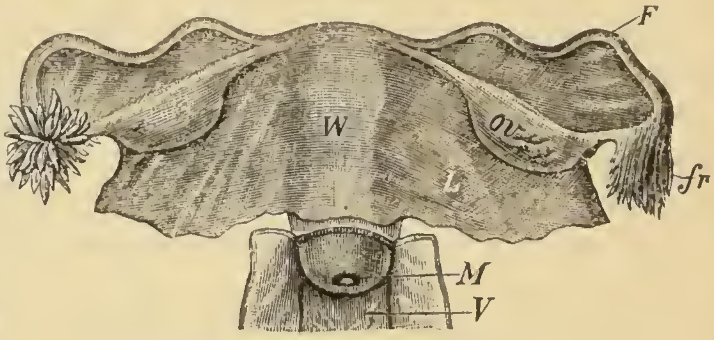


Fig. 206.—The Womb and its Appendages.

W, the womb. *ov*, the left ovary. *F*, the left fallopian tube, and *fr*. its extremity. *L*, the ligament of the womb. *M*, The mouth of the womb. *V*, the genital passage, opened up.

The vaginal orifice is partly closed behind by a fold of mucous membrane called the **hymen**. Sometimes the hymen completely closes the passage. Between the back wall of the vaginal passage and the place where the labia majora meet at an angle behind is a crescentic fold of mucous membrane, called the **fourchette**, which is torn in labour. The part between where the labia majora meet behind and the opening of the bowel is called the **perinæum**. The tear of the fourchette in labour sometimes passes back into the perinæum, and may reach the bowel. This perinæal tear ought always to be stitched.

The **vaginal passage** passes inwards, backwards, and upwards, and ends blindly. Into the upper wall of the blind extremity projects the mouth of the womb, the front wall of the passage passing up in front of the lips of the womb and the back wall behind the lips. The front wall of the passage is thus slightly shorter than the back wall, being 2½ inches, while the back wall is 3½. In front of the front wall, and between it and the pubic bone, is the bladder, and behind the back wall is the lower end of the bowel.

A finger passed into the vagina will thus come into contact at its inner blind end with the lips of the womb.

The female generative organs situated within the body are the womb or uterus and certain appendages, the ovaries, and tubes which lead from them to the womb. The relation of these parts is shown in Fig. 206.

The Womb or **Uterus** is situated deep in the cavity of the pelvis (p. 63) between the bladder, which lies in front of it, and the end of the large bowel, which lies behind it. It is pear-shaped, and is on an average 3 inches long, 2 broad, and 1 thick. It is composed mainly of muscular fibre of the involuntary kind (p. 113). In its centre is a narrow cavity (the walls being very thick) running up towards the broad end of the pear-shaped organ, and opening at the narrow end at what is called the mouth of the womb. The inner surface next the cavity is lined with mucous membrane (p. 195), in which there are glands. The organ is richly supplied with blood-vessels and nerves. By means of a transverse slit, the lips of which are, however, in the virgin state closely applied to one another, the mouth opens into the passage of the vagina, which communicates with the outside and is about 3 inches long. The womb is kept in position by ligamentous structures, which are lax enough to admit of a moderate degree of movement. Now the womb is flattened on its front and back walls, and if a pear be imagined as pressed somewhat flat in this direction it will be easily understood that the appearance of a corner at each side of the broad end will be produced. The womb has such a corner at each side of its upper end, and from each of these corners a tube passes off, the **fallopian tubes.**

Fallopian Tubes.—Each tube has the appearance of a thick cord 3 or 4 inches long. It consists mainly of muscular tissue like that of the womb, and in the centre of its whole length runs a canal, the inner wall of the tube being lined by a membrane also like that of the womb, but having no glands embedded in it. At the end next the womb the canal will admit only an ordinary bristle, but at its other end it is wider. The end distant from the womb opens into the cavity of the belly, is trumpet-shaped, and provided with fine finger-like projections or fringes. (See Fig. 206, *fr.*) The tube of each side is further connected with the womb by a broad band of tissue, a ligament. Connected with this ligament is the **ovary,** one on each side of the body.

The Ovaries are flattened oval bodies, each about $1\frac{1}{2}$ inch long, $\frac{3}{4}$ inch wide, and nearly $\frac{1}{2}$ inch thick. They are attached to the womb by means of the broad ligament referred to, and to one part of the ovary the fringe of the fallopian tube of its own side is connected. It is in the ovaries that the ova are produced, the female element in the production of new beings. The ovaries are supplied with many nerves and blood-vessels. Each ovary contains a multitude of ova or eggs in different stages of growth. In the ovaries of a female child at birth they are already visible, and it has been estimated that no less than 70,000 may be present in the two. Each ovum or egg is about the $\frac{1}{100}$th of an inch in size. Fig. 207 shows a section or slice of an ovary, the little round bodies being the ova, those near the surfaces (5) being undeveloped, those deeper (6, 7, &c.) being more mature. In process of growth the ova pass more deeply into the substance of the ovary. Instead of lying in groups, one becomes separated from others by growth of substance between them. As one becomes more mature it becomes surrounded by an envelope or capsule, which, by and by, forms a sort of bag round it. The ovum becomes attached to one part of the wall of the sac, and fluid is produced separating the rest of the wall from it, and the fluid increases till the egg is, as it were, connected to the inner wall of a minute bladder. (See Fig. 207, 8 and 9.) As it grows, the sac with its ovum approaches near the surface of the ovary till it bulges from the surface. The continued increase of fluid finally causes the little bag

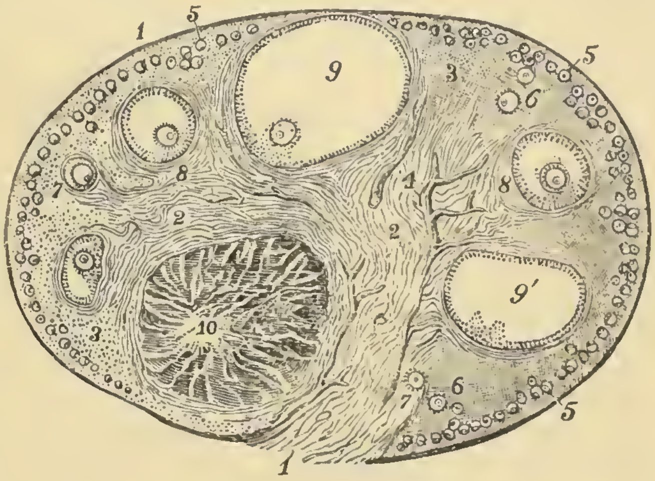


Fig. 207.—Section of Ovary magnified, showing ova in various stages of growth.

1, Capsule of ovary. 2, Fibrous substance of ovary. 4, Blood-vessels. 9′, Sac from which ovum has been removed. 10, Space from which ovum has been discharged filled up with blood-clot, &c. For meaning of other numbers, see text.

to burst, and the ovum is discharged. The ovary at this time is very freely supplied with blood. The discharged ovum would readily drop into the cavity of the belly but for the fact that at this time the fringed end of the fallopian tube is applied to the ovary, and the ovum is received into the canal of the tube, and passes down the canal till it reaches the womb.

Thus during the early years of a girl's life the ovary is developing, and the ova it contains are maturing. It is not till the twelfth year or upwards that the first ovum becomes ripe and is discharged, and when that period is reached the girl has arrived at the age of puberty, that is, the age when she is capable of conceiving. At the time when an ovum is about to be discharged, changes take place in the womb; an extra supply of blood reaches it, and the changes occur which lead to the appearance of the discharge. From the time when the first ovum becomes mature and is discharged, as a general rule, one becomes ripe after another at intervals of twenty-eight days. Thus from thirteen years or so onwards, regularly every month, an ovum becomes mature and is discharged, and its period of ripening and discharge is attended by the changes in the womb alluded to, and so there is the periodical occurrence of the monthly illness. For a certain number of years—up to the age of forty-five or thereby—these changes regularly take place till the organs becomes exhausted, the period of the "change of life" arrives, these occurrences cease, and the capacity of conception has passed away.

MENSTRUATION.

Menstruation (*The Menses—Monthlies—The Periods—The Courses*) is the term applied to the process whose external evidence is the discharge from the genital organs. The word is derived from the Latin *menstrualis*, meaning monthly, from *mensis*, a month.

The discharge comes mainly from the inner surface of the womb, and while it lasts the womb is in the condition of having a greatly increased blood supply, and of being in consequence fuller and heavier than during the interval between two periods. These changes in the womb, as already noted, are coincident with similar conditions in the ovary, attending the ripening and discharge of an ovum. In the virgin condition the ovum passing down the fallopian tube into the womb undergoes no change except that of breaking down and becoming dissolved.

Time of Appearance.—It is some time between the ages of twelve and sixteen years that the appearance of the monthly discharge indicates that the internal generative organs have arrived at some degree of maturity. Even before that occurrence various other signs indicate a change coming over the girl. An alteration takes place in the figure and gait owing to expansion of the hips and fuller and more rapid development of the breasts. The whole figure becomes more plump and rounded, and the girl less awkward and angular, and more graceful. Her manners also change. She becomes more sedate and less wayward, more timid and bashful, but also more gentle and loving. The actual period of the first illness varies with the climate and other circumstances. In Britain the age of sixteen is that at which it most commonly begins; in France it is earlier. The general rule is that it appears earlier in warm countries and later in cold countries, the mean being in a temperate climate. The date of appearance is also affected by the conditions of life. It is earlier among those who live in towns, and later among country girls. Luxurious habits of living, the use of warm, stimulating foods, &c., hasten it; while among those whose lives are more simple and primitive, or who live among conditions of hardship, it is delayed. It is also influenced by the constitution, and its appearance may be long delayed in a delicate girl. There are also exceptional cases on record, cases where the illness has appeared remarkably early, or where it has not appeared for many years past the usual time.

Symptoms.—The first monthly illness is frequently accompanied or preceded by some degree of feverishness, pains in the back, a sense of fulness in the abdomen, and feelings of great weariness. It is also a time when a girl may manifest a variety of nervous symptoms, and may be liable to hysterical attacks. The first portion of the discharge is clear, later it is tinged with blood, and gradually it becomes almost pure blood, the blood then gradually diminishing till finally the discharge becomes free from blood and then ceases. The symptoms which preceded and accompanied the discharge pass off, and in a few days the girl is in perfect health.

The regular illness is not established all at once. The girl may suffer from some of the preliminary symptoms, which lead the mother to conclude her illness is going to begin, and after a few days they may pass off without any or but a very slight discharge appearing. And this may occur at one or two periods without any flow of blood. Or one illness may occur in the regular way, and one or two periods may then pass with only a threat of its occurrence. Parents must not be alarmed at such irregular occurrences. Nor are they to take, as is too often done, any steps to force the discharge, such as administering drastic purges and other kinds of medicine. The general health of the girl remaining good, no alarm need be entertained, and in any case no haphazard methods should be resorted to. (Refer to p. 622.) One thing it is desirable to notice here. The external passage (vagina) is almost closed in the virgin by a membrane called the **hymen**, which stretches across it near its entrance. Through a narrow opening in its centre, or through several smaller openings, the discharge from the womb escapes externally. In rare cases no opening exists, and the discharge does not escape, but is pent up within. The girl may, at the usual time for the appearance of the discharge, have the symptoms that have been noted, but there is no flow; and thus one period after another may pass, the discharge accumulating behind the barrier. The accumulated discharge will in time form a swelling, even though it gives rise to no other symptoms, and there will be the appearance of a tumour in the abdomen enlarging with each returning period. This, taken with the absence of any discharge externally, has more than once given occasion for most unjust suspicion. In such a case as this the point to note is that on no occasion has the discharge ever appeared. If any discharge had at any period appeared, it would have proved that the way was open.

Once the discharge has been fully established it should return at the regular periods during the whole of the child-bearing epoch. It is, however, interrupted by pregnancy, and does not, as a general rule, occur during suckling. Its disappearance under any other circumstances is to be regarded as a disturbance of health, which will probably be attended by other symptoms also.

The Duration of each Illness varies in different persons. According to one authority the most common length of time is eight days, then three, and then four. The quantity of discharge during one period it is also impossible to state with definiteness. From 2 to 6 ounces may be stated as extremes which are within the limit of health. Any larger quantity should lead one to seek competent advice. While four weeks is the usual time that elapses from the beginning of one illness to the beginning of the next, there are variations quite consistent with health. One woman may "alter" every three weeks, and another only every six weeks. All departures from what is stated to be the general rule are to be judged by the custom of each person and by the condition of her general health.

The Change of Life.—At the age of forty-five or thereby, earlier or later in different individuals, the regular periodical illnesses begin to cease. They rarely cease at once, but become irregular. The "illness" returns at irregular intervals, and gradually the discharge diminishes in amount. It also greatly varies, being at one time scanty and at another very profuse, till it finally ceases. The womb at this time becomes smaller in size, and the ovaries shrivel rapidly. At this time the woman is in an unstable condition of health, and liable to many minor ailments, and also to some more serious. She is liable to headache, flushings of the face, and disturbances of the digestive and nervous systems. When this period is safely past, however, a time of good health may be looked forward to with some confidence.

This period in a woman's life is also called the **climacteric,** and also **menopause.**

Vicarious Menstruation.—This is the term which has been applied to a discharge of blood coming periodically from some part of the body other than the womb, and taking the place of that discharge, which is absent or very scanty. Instances of such menstruation are not very common. But there have been cases in which bleeding from the lungs, stomach, nose, &c., occurred at the usual period, and seemed to be the means of relieving the system when the ordinary discharge was wanting or scanty.

THE MANAGEMENT OF THE MONTHLY ILLNESS.

Details of the nature of the monthly illness have been given above, in so far as they seemed advisable for the purpose of communicating some intelligent appreciation of the character of occurrences of which every woman's body is the seat. It is but in accordance with reason and common sense that a woman should have some degree of accurate knowledge of so important a function. Disturbances of this function are surprisingly common, are, indeed, apparently becoming more and more common, many of the conditions of modern life directly disposing to them. That they are the cause of much suffering, borne largely in silence because of the natural modesty of women and dislike to seek advice on so delicate a subject, is known to every medical practitioner of even limited experience. Ignorance is undoubtedly mischievous, and a certain amount of knowledge on the part of every woman desirable. Nowadays the only question is how, when, and by whom ought the necessary information to be imparted to every girl. Every medical man recognizes that a little knowledge of the subject would enable women to avoid much of the misery and suffering they incur by their ignorance. For this purpose the above details have been given as plainly and simply as seemed to suit the circumstances of the case, and for the same purpose the following general directions as to the management of the "illness" are given.

It is because the occurrence of the monthly illness is natural and periodic that women, so familiar do they become with the process, pay little heed to its indications, and do not much take it into consideration in regulating their habits of life. In arranging for their work or their pleasure too little account is taken of it, though every woman knows pretty accurately the time of its return. Even when some disturbance arises connected with it, less attention is paid than would be to disorder of the same extent of any other function. All this is the very reverse of what ought to be. For, at the very outset, it must be remembered that at the period of the illness the whole system is in a highly-strung condition, extremely sensitive to every variety of influence; the nervous system, in particular, is peculiarly impressionable, and the person, therefore, more open than at any other time to disorder of various kinds. It would only, on this account, be in accordance with reason and common sense that special care should be taken while the illness lasts, and for a brief period both before it and after it, to maintain good bodily health, and to guard against everything likely to affect it. Thus common sense would suggest that exposure to cold, to damp, to draughts, and such like should be avoided. Thus during the period mere jumping out of a warm bed and placing the bare feet on a cold floor or wax-cloth has often been the cause of serious illness. Wet clothing and wet feet are specially hurtful. If women would not permit the familiarity of the process to make them forgetful, it would not be necessary to insist on these obvious precautions. It requires very little thought, moreover, to make one perceive that, at a time when so much bodily energy is directed to one function, and when so great a drain on the system is present, less, considerably less, than the usual amount of exertion ought to be undertaken. Indeed, during the days that the illness lasts, much more rest than is customary ought to be indulged in, no work requiring any strain should be undertaken, fatigue should be carefully avoided, the ordinary duties should be lightened, and some rest and quiet taken during the day. This is not always possible; but every endeavour ought to be made, even when the usual day's duties must be performed, to make them as light as possible, and to undertake no exertion that can be avoided. If this is so with even necessary duties, it is excessive foolishness for a woman to expose herself to undue excitement during the period, specially the excitement of a round of pleasure or gaiety. Social gatherings, dances, games implying physical exertion, such as lawn-tennis, boating, riding or walking excursions—all these should be refrained from at such a time. Those who are in charge of houses ought not to leave the illness out of account in arranging their domestic concerns. The dreaded "spring cleaning" and the inevitable "washing day" ought to give way when necessary, and mistresses ought not to forget that some days of apparently slovenly and half-hearted work may have a reason other than that of idleness or carelessness, and ought, when needful, to lighten the burden of work to their servants accordingly. Those who have the care of young girls, whether their own daughters or not, do not fulfil their duty to them unless they exercise supervision over them sufficient to prevent them by their ignorance incurring needless risks.

Warm clothing is particularly needed during the period. Of the kind of clothing enough has already been said, but the desirability of some flannel clothing may again be urged.

Diet during the Period.—As regards food, not much special direction ought to be required.

In the sections on Food full explanations are entered into regarding the quantity and quality of foods necessary for the maintenance of vigorous bodily health, and the relation of these to work is discussed. But it is plain that when special demands are made on the system, as they are at each recurring menstrual period, special care needs to be taken that a due quantity of nourishment is supplied. At such a time any deficiency in quantity of food or any error in kind will become most evident and most hurtful. Often at this period women are less inclined for food when it is most needed, and are too prone to quiet any appetite that is present with cups of tea, which, while they refresh and stimulate for the moment, supply no real nutriment. Plain, simple, easily-digested food of the ordinary kind at regular intervals is very necessary. At the same time, too plentiful or too rich feeding is also injurious. Rich dishes, pastries, &c., are not to be encouraged.

The Abuse of Stimulants during the Monthly Period.—It is too common to attempt to relieve the feeling of depression or exhaustion by stimulants. They cannot supply the place of appropriate nourishment, and are apt to lead to bad habits. It is always those who do not take fit nourishment that are most prone to turn to stimulants, and it is always they who are most injuriously affected by alcohol, since it quickens the waste going on in the body without affording any material to supply it. As a general rule the use of stimulants is to be condemned. The circumstances that make them useful are considered in discussing scanty and excessive menstruation in the succeeding section.

Exercise during the Period.—The question of exercise for girls is as important as for boys, and is discussed elsewhere. It is only necessary to say here that, during an illness, as much rest should be taken as possible, and for a day or two after the period also. Active exercise during that time is the greatest possible mistake.

Bathing during the Period.—Bathing is to be avoided during the illness, and in particular cold bathing.

PREGNANCY AND ITS MANAGEMENT.

CONCEPTION.

The Female Element in Conception.—Every four weeks, as has been stated, in the adult woman, an ovum becomes ripe and is discharged from the ovary. It is caught by the extremity of the fallopian tube and passed down the tube towards the womb. If the changes arising from conception do not occur, the ovum breaks down and disappears. If, however, shortly before it leaves the ovary, or during its descent of the fallopian tube, the ovum is met by the male element, which enters into it and fertilizes it, a set of changes occurs in it which leads to the formation of a new being.

The Male Element in Conception.—The material supplied by the male, called the spermatic fluid, consists of a thick whitish fluid, in which the microscope reveals curious bodies, represented in Fig. 208, formed of an oval part, called the head, which is about the $\frac{1}{6000}$ of an inch long, and of a tail, the $\frac{1}{400}$ of an inch in length. They are called spermatozoa, and they are the essential element supplied by the male for conception. The fluid having been introduced into the female in the act of sexual intercourse, the spermatozoa find their way upwards into the womb and on to the fallopian tube, partly by the lashing movements of the tail, and if in their course they meet an ovum, still in fit condition, one or more spermatozoa entering it produce conception. Among the earliest changes that thereafter occur in the ovum is one by which, from the original single cell, a mass of cells is produced. Fig. 209 shows at 4 ova, magnified. Soon after the entrance of the spermatozoa the ovum divides into two (1 of fig.); each of these two then subdivides into two, making four (2 of fig.); each of the four subdivides, so that eight are formed, and the process goes on to sixteen, thirty-two, sixty-four, &c., until a mulberry-shaped mass of cells (3) is formed, all derived from the original single cell or ovum. This process is supposed to occupy about eight days, and to occur while yet the ovum is descending the fallopian tube, and about the end of that time it reaches the

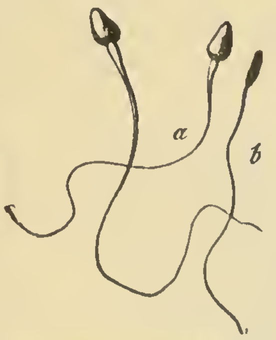


Fig. 208.—Spermatozoa, the male element in conception.

womb, which has meanwhile been prepared for its reception, and where it is detained till the new being is more fully formed. It is from the mass of cells thus produced that the body of the child is gradually developed.

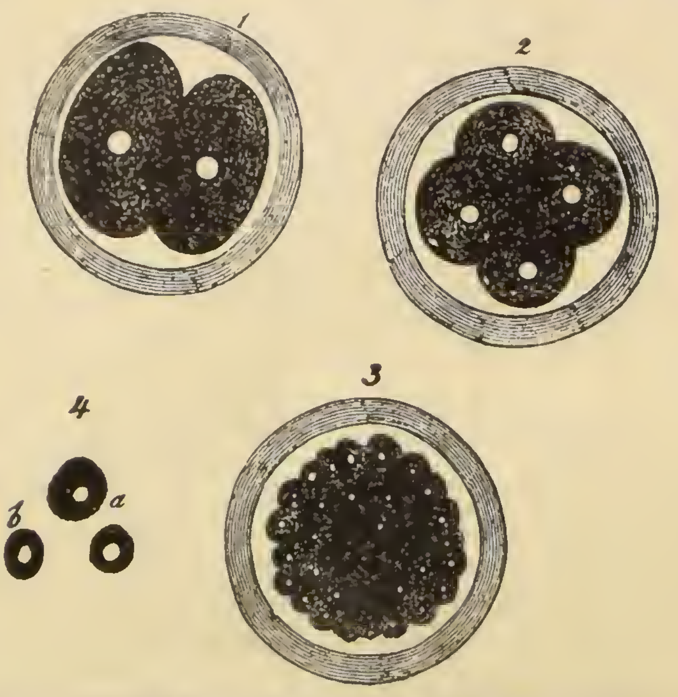


Fig. 209.—First Changes in the Ovum after Conception. 1, 2, and 3 are enormously magnified; 4, less so.

The Date of Conception.—While conception is more likely to result from connection shortly before or within a few days after an "illness," there is really no period at which intercourse may be had and conception not be possible.

THE GROWTH OF THE OFFSPRING.

The Embryo and Fœtus.—When the ovum which has been fertilized by the action of the male element reaches the womb it is not much larger than its original size, about the $\frac{1}{120}$ of an inch. It becomes attached to the walls of the womb in a peculiar way. Before its arrival changes take place in the inner lining membrane of the womb, causing that lining to become much increased in thickness, and owing to the increased thickness the surface is thrown into ridges and furrows. The small ovum apparently is detained in the womb by falling into one of these depressions, and becoming buried, as it were, by the ridges of the thickened wall growing round and over it. About the third or fourth week after conception the ovum has become completely imbedded in the wall, in which it forms a little swelling. Meanwhile by this time the surface of the ovum is not smooth and regular as it originally was, but is covered by a set of shaggy projections, termed **villi**. These villi are the result of changes going on rapidly within the ovum. They become imbedded in the substance of the wall of the womb, which completely surrounds the ovum, and thus an intimate connection is effected between the body of the mother and the growing offspring. At this period the condition of things is represented in Fig. 210, where the ovum with the shaggy projections of its own lining membrane is shown resting on the wall of the womb, which has grown up around it so as completely to surround and cover it. The ovum is thus shut up in a little chamber in the wall of the womb, and is shut off from the cavity of that organ.

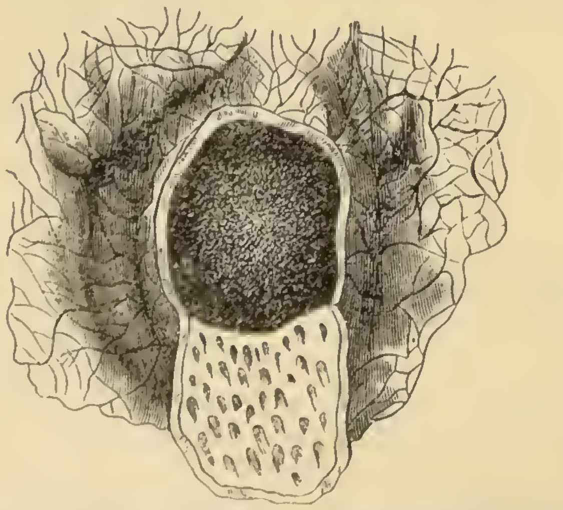


Fig. 210.—Attachment of the Ovum to part of the Wall of the Womb. Part of the membranes covering over the front of the ovum has been turned down.

In the early period of its formation the new being is called an **embryo**, and in the later period before birth it is called a **fœtus**.

It is evident from Fig. 210 that as the embryo grows the swelling in the wall of the womb will grow larger and larger, and will gradually encroach on the space belonging to the cavity of the womb, until at length, with increased growth, the part of the wall which covers over the embryo will bulge right across to the opposite side, will, in fact, come into contact all round with the rest of the wall of the womb, and will become merged into it. This happens after the second month of pregnancy. The shaggy projections, that have been mentioned as growing out from the wall of the ovum, undergo increased growth at that part of the ovum in immediate contact with the part of the womb on which it rests, and at that place blood-vessels come to occupy their interior. At other parts of the ovum they shrink and disappear.

Formation of Placenta or After-birth.—That part of the wall of the womb on which the ovum rests undergoes special development, and as the result of the special growth on the part of both the womb and ovum at that place, a special structure is formed, called the placenta, by which the structures of the embryo and those of the mother come into intimate relationship, and in which the blood belonging to each comes into such close contact that exchanges of material can take place between them. It is by means of the placenta that the nourishment of the growing offspring is obtained, it being a bond of union between offspring and mother, the agent through which nourishment is conveyed from the blood of the mother to the child. The placenta is also called the **after-birth**, from the fact that after the birth of the child it is separated and expelled from the womb. By the end of pregnancy it forms a disc-like mass, measuring 7½ inches across, ¾ inch thick, and about 20 ounces in weight. Connected with it near the middle is the **umbilical cord**, by means of which the growing embryo is attached to the placenta. Running within the cord are two arteries which carry the blood *from* the embryo to the placenta. In the placenta the blood is distributed in large spaces, and comes into close communication with the blood of the mother, by means of which its purity and nourishing qualities are maintained. From the placenta the blood passes back along the cord in a vein to the embryo, to which it gives up the requisite supply of material for continued life and growth.

Formation of Membranes.—To return to the ovum. We have seen that after conception it divides into two cells, then into four, and so on, till a mass of cells is produced, which dispose themselves in such a way that a hollow sphere is formed. It is from the outer layer of this sphere that the shaggy projections are thrown out which become connected with the part of the wall of the womb that has covered over the ovum, forming an outer membrane. On a part of the sphere the embryo begins to develop, and as it grows the parts of the sphere beyond the place where it is developing rise up round it, and finally meet and close over it. Thus the embryo comes to be enclosed within a membranous sac of its own, called the **amnion**, while it maintains its connection with the parts beyond by a cord, the **umbilical cord**. As the embryo grows, fluid is formed within the sac, and thus the embryo, as early as the second month, is floating in fluid contained within a sac, and connected with the wall of the mother's womb by means of a cord and the placenta. With further accumulation of fluid the amnion enlarges till it comes into contact with the outer membrane already mentioned, with which it becomes fused. So in the later stages of pregnancy the fœtus is freely movable in a mass of liquid contained within a large sac formed of the blended membranes, and is suspended in the liquid by the cord, the other end of which is attached to the placenta, which is in close connection with the wall of the womb, the womb itself being completely filled by the sac and its contents. In the course of labour the membranes are ruptured and the liquid escapes, in common talk, "the waters break".

Progress of Growth at Different Months.—In the course of the third month of pregnancy, the ovum, with its growing embryo enclosed within its membranes and floating in the fluid, comes to occupy the whole cavity of the womb. As the embryo continues growing the womb must needs enlarge with it.

After the end of the third month of pregnancy the growing offspring is called a **fœtus**, and is so called till birth takes place. At this time the fœtus measures from 5 to 6 inches in length, and weighs about 4 ounces. Already at this time the sex is distinct, the outline of the body is complete, the eyes and ears are formed, and the nails have commenced to form.

At the end of the fourth month the fœtus has increased to 7 inches in length, and nearly 9 ounces in weight. A slight down, instead of hair, begins to appear on the scalp and surface of the body, and brisk movements occur, though they may not yet be felt by the mother.

With the end of the fifth month the length has increased to from 8 to 10 inches, and the weight from 10 to 12 ounces. Early in the fifth month the first movement is usually detected by the mother, and this is called the period of quickening, though, as has already been said, this is only the time when the mother feels the movement, which has previously occurred unperceived by her.

At six months the growing child is 11 to 12½ inches long, and weighs more than a pound. The nails are solid, and eyebrows and eyelashes have begun to form.

In the course of the seventh month the length increases to from 12½ to 14 inches, and the weight is considerably increased by deposit of fat under the skin. In the male child the testicles begin to descend from the cavity of the belly towards their proper position.

By the end of the eighth month the length of the child is usually about 17 inches, and the weight 4 to 5½ pounds. The skin is red and covered with down. In the male child one testicle has completely descended, usually that of the left side.

Size and Weight of Child at Birth.—At birth the average length is from 19 to 24 inches, and the average weight 7 pounds.

Male children are usually larger than female children. While 7 pounds is an average weight, there are many variations. 5½ to 6 pounds weight means a very small child, and 12 to 13 a very large child, but such extremes are now and again met with.

THE DURATION OF HUMAN PREGNANCY.

The process going on within the body of the mother in the production of offspring is called **gestation**, and the whole time occupied by the process is called the **period of gestation.**

In the human being the length of this period, that is, the average duration of pregnancy, is between 274 and 280 days, or about forty weeks. It is roughly counted as nine calendar months. This period should be estimated from the time of conception to the time of birth. But the time of conception, that is, the time when the male element meets the ovum and enters into it, it is impossible to learn, for the period of conception is not necessarily the same as the period of sexual intercourse. The ovum may be fertilized even before it has left the ovary, or in any part of its course down the fallopian tube before reaching the womb. Conception may not take place thus for several days after intercourse, or it may take place shortly after intercourse, according to the distance the spermatic fluid has to travel before reaching the ovum. The time is, therefore, dated from the end of the last monthly illness, and the usual course is to count 280 days from the last day of the last illness.

While 280 days have been mentioned as the ordinary duration of human pregnancy, there is good reason for believing that very considerable variation in the length of time may occur and yet the pregnancy be a perfectly natural one. Cases are on record where the only possible conclusion was that pregnancy had extended to 295 days. In Scotch law, and according to the French Code, the utmost limit is 300 days.

Probable Date of Confinement.—Conception is believed usually to occur about a week after the end of the last illness; the duration of pregnancy is counted as nine calendar months, so that the time of confinement is likely to occur nine months and one week from the last day of the last illness, that is, about 280 days. This supplies a ready method of counting. From the last day of the last illness reckon nine months forwards, and add seven days. Thus, a woman ceased to be ill on the 7th January; nine months forwards gives the 7th October, and adding seven days we have the 14th October as the probable date of delivery. A shorter method is to count three months back instead of nine months forwards, and then add the seven days. Thus three months back from 7th January is, of course, 7th October, and seven days gives 14th October as before. As another example, suppose the 10th February to be the last day of the last illness, three months backwards gives the 10th November, and adding seven days we get November 17th as the probable date of confinement.

This method of counting is based on the fact that, as a general rule, the monthly illness ceases during pregnancy. But the ovum that becomes fertilized may not be the one whose ripening was at the time of the last monthly illness, but it may be the ovum of the succeeding month, whose maturing was not attended by the monthly discharge, because conception had occurred. That is to say, conception may have occurred either within a few days after the last illness, or immediately before the succeeding illness was due. This gives a difference of three weeks. If, then, one has accurately known the last day of the last monthly illness, and has properly counted 280 days (or nine months and seven days) from that time, and if the confinement does not occur within a week after the estimated date, it may be expected not to take place for an additional fortnight, that is, altogether, three weeks after the originally fixed date.

SIGNS OF PREGNANCY.

It may at the very outset be observed that up to the fourth month it is not possible to obtain any certain sign of pregnancy. Indeed, it may be said that the eighteenth week is about the earliest time when any really reliable evidence can be procured. It is possible for experienced persons to be deceived even long past that period, and women who have already borne children are occasionally themselves under the delusion that they are with child up to a time very close on that at which confinement would be expected. At the same time there are signs present very early in the course of pregnancy that, in ordinary cases, are accepted as sufficiently conclusive, which, however, ought not to be taken as satisfactory evidence against a woman protesting against such a conclusion. These early signs are:

stoppage of the monthly illness,
morning sickness, and
changes in the breasts.

Stoppage of the Monthly Illness (*cessation of menstruation*) is usually the first sign of pregnancy, for as a general rule throughout pregnancy there is no discharge whatever. There is, however, a number of cases in which the monthly illness does not cease immediately after conception, but goes on for a month or two thereafter, creating some doubt in the woman's mind as to the period of conception. In a smaller number of cases the illness occurs almost as usual, up to even the fifth or sixth month, and in much fewer cases seems to occur regularly throughout the pregnancy. Some doubt may be occasioned in such cases, as has been already said. It is, however, much more important to remember that the monthly illness may cease for many reasons totally unconnected with pregnancy. It is quite common for the illness to become very irregular, to recur at long intervals, or to cease altogether for many months in young persons, as an effect of a depressed general system, or of some disturbance of health totally unconnected with the generative organs. Various disorders of the generative organs also cause interruption of the periodic illness for long periods. While, therefore, cessation of the illness in a married woman will quite properly lead one to suspect the occurrence of pregnancy and to seek for further evidence, it would be grossly improper on account of this alone to suspect anything of the kind in the unmarried. Unfortunately this has too often been done most unjustly and with most unhappy results. Such a sign as this must not be interpreted by itself. For instance, it has happened that, while as regards the womb itself the illness has occurred, the discharge has not found an outlet owing to some obstruction of the passages. The discharge has been pent up within the cavity of the womb; and this has gone on month after month, the material accumulating within the womb and producing enlargement, and, when it has gone on long enough, the appearance of swelling of the abdomen. Such swelling, taken with no appearance of monthly illness, has seemed conclusive evidence of pregnancy, with grievous results to innocent persons. By itself, then, this suppression of monthly illness is not to be held as offering any sufficient evidence one way or another.

Morning Sickness is another common occurrence early in pregnancy, but like the former it is not constant, nor yet is it reliable. It is specially in the morning and early part of the day that the sickness is felt, hence the phrase "morning sickness," and it wears off as the day advances. The feeling of sickness is generally accompanied by vomiting. It is commonest in the first months of pregnancy, beginning about the fourth or fifth week, and often disappears after the womb begins to rise up into the cavity of the belly, that is, in the course, of the fourth month; but it occasionally lasts through the whole nine months, producing much distress and great exhaustion. After the few early months it may disappear, to return during the last months, owing probably to local irritation of the stomach caused by the proximity of the much-enlarged womb. Many mothers hardly suffer from it at all. Others are not afflicted with sickness, but with other kinds of digestive trouble, heartburn specially, water-brash, flatulence, acid indigestion, and so on. Different persons are affected in this respect in different ways, and even as regards the same person the course of one pregnancy may be very different from that of another. One curious form of digestive disturbance is the aversion that may arise for certain foods formerly enjoyed, and the craving for others of an unwholesome and, in some cases, even loathsome character.

Changes in the Breasts begin in the early weeks, and are at first feelings of fulness and tenderness, and sometimes even of sharp pain. The breasts feel firmer to the touch also, and the veins of the skin over them are more marked. About the ninth week the nipple is more erect and prominent, from the greater supply of blood. Around the nipple is a dark circle, called the **areola**. After the ninth week the colour of this areola deepens, and the areola itself becomes larger; the little elevated points present in the ordinary condition of the breast become more prominent and marked. These appearances are always much more pronounced in dark than in fair women. In dark women, also, about the fifth month, an outer circle of faint colour may be perceived, called the **secondary areola**, which has been described as presenting the appearance produced on a dingy white, or tinted surface, by drops of water falling on it and taking out the colour. The deepening of colour is due to the deposit of an additional quantity of pigment in the deep layer of the skin, and, since the deposit is more or less permanent, the change is most marked in first pregnancies.

Increased darkness of colour also occurs in a line about a quarter of an inch broad along the middle line of the belly from the navel downwards.

In some women also patches of a yellowish-brown colour appear on the forehead, cheeks, breast, and neck, which, however, disappear shortly after the birth of the child.

These signs, then, of suppression of the monthly discharge, morning sickness, and similar digestive disturbances, and changes occurring in the breasts, are the earliest indications of the pregnant state. Not one of them, however, taken alone, is to be regarded as offering satisfactory proof of that condition, but all taken together, while not affording conclusive proof, are to be regarded as very strong presumption of such an occurrence.

Among the later signs of pregnancy are—

enlargement of the abdomen,
movements of the child—quickening, and
detection of the sounds of the child's heart.

Enlargment of the Abdomen does not occur till towards the fourth month, when the womb begins to rise upwards from the cavity of the pelvis (p. 63) into the abdomen. In the earlier weeks the increased weight of the womb, due to its added contents, causes it to sink more deeply in the pelvis, and this produces in the second month rather a flattening of the surface of the belly.

By the fourth month the womb, requiring increased room, has risen upwards, and may be detected above the edge of the bony ridge in front. By that time the person will be conscious of an increasing tightness of the dress, and by the end of that month the hollow round the navel is less marked than usual.

A progressive increase in size occurs till, at the seventh month, the hollow has disappeared, and the navel is on a level with the rest of the skin, after which time it begins to extend beyond the general surface. But, as with the other signs, this one must not be considered alone, for a tumour in the belly, dropsy connected with the ovaries, discharges pent up within the womb, as already noted (p. 627), and other causes will produce enlargement, which only skilled persons can distinguish from one another. Nor yet can this sign be taken along with that of suppression of the monthly illness as conclusive evidence of pregnancy, because monthly discharges prevented from escaping will occasion both conditions.

Movements of the Child—Quickening.—A mother first becomes conscious of the movements of the child in the womb at a period, roughly stated, about the middle of pregnancy. More accurately it is from the sixteenth or seventeenth week of pregnancy onwards that the movements may be detected, and if the date be noted, it affords valuable aid in determining the probable time of delivery. The period at which these movements are felt is called the **period of quickening**, because it was thought that then for the first time the child became active. In reality it is active before this, but about this time the enlarging womb comes into contact with the belly walls, and so the movement becomes sensible to the mother. The sensations are actually due to movements of the child—kicks, movements of the knees, &c.,—and are at first felt as feeble flutterings, which, as pregnancy advances, become more and more pronounced, till they may even occasion pain and cause the mother to cry out.

By the fifth month they may be excited by pressing with the hands from the outside on the belly walls. In later stages the movement is easily visible, and one may be able to feel with the hand the outline of a knee, &c., as it passes along the wall of the womb. Now this is one of the most convincing signs of pregnancy, but it is yet possible to be in error regarding it. Rapid movements of gas in the intestine, irregular contractions of the muscles of the belly wall, heaving movements due to a bulging of the wall of a large artery (aneurism), &c., may be mistaken for movements of a child, and have been so mistaken by women who had previously borne children. Moreover, cases of what have been called "**phantom tumour**" have occurred, in which enlargement of the belly and the sensation of jerking movements were due to spasmodic contractions of the muscles of the walls of the belly.

The Detection of the Sounds of the Child's Heart is a sign which affords unmistakable evidence of pregnancy. The beating of the child's heart may be detected about the eighteenth week of pregnancy. It is found by placing the ear on the belly at a part midway between the navel and the bony part at the bottom of the belly, and a little either to the left or right. Instead of applying the ear directly, the stethoscope is commonly used. The beat is distinguished from the pulse of the mother by its rapidity. It generally ranges from 130 to 160 per minute, and is more rapid in female than in male children. The position mentioned is the one in which the sound is heard, because at this stage of pregnancy the child is usually placed head downwards, with its back forwards and to the left or right, usually to the left. Some portion of its back is thus brought into contact with the front wall of the womb, and as the womb is in contact with the belly wall the sound is conducted. The child may, however, be lying in some unusual position, so that the sound is not conducted to the place mentioned, and it may be difficult to find any part of the belly wall at which it is heard. While, therefore, the detection of the sound is conclusive evidence of the presence of a child and of its life, the non-detection must not be taken as conclusive evidence of there being no pregnancy or of the death of the child. It will therefore be understood that this is a sign requiring to be sought for by a skilled person.

There are other signs a physician would endeavour to find to confirm his view of the presence or absence of pregnancy, but it is needless to detail them here.

On the whole, then, it will be evident that it is not always an easy matter to settle definitely whether a person be pregnant or not. The absence of the monthly illness, the occurrence of morning sickness, of changes in the breasts, and of enlargement of the belly may lead one to entertain a strong positive opinion, and yet that opinion may be mistaken. If, however, a competent person detects with certainty the beating of the child's heart, continued doubt is not possible. This cannot, however, be detected much before the fifth month. The necessity for caution in coming to any conclusion, particularly in certain circumstances, cannot, therefore, be too strongly insisted on.

THE MANAGEMENT OF PREGNANCY.

The months of pregnancy are periods of considerable anxiety and trouble to most women, and are especially so to those who pass through them for the first time. It is natural that women pregnant for the first time should seek advice and counsel from more-experienced female friends, who are, as a rule, too willing to offer the results of their experience, and to impress their lessons on the mind of their less-experienced friend. As a rule, however, the advice is as various as it is plentiful, and often very conflicting. It is, moreover, so often accompanied and enforced by narrations of misfortune and trouble that the mind of the receiver is often perplexed and confused, and also filled with grave fears, which she can hardly utter. Now it must not be forgotten that pregnancy is a natural process, that nature is usually sufficiently able to accomplish well her purposes, and that the vast majority of pregnancies, if allowed to pursue, without meddlesome interference, their natural course, end naturally, easily, and successfully.

The woman, who is looking forward with some quite natural anxiety to the birth of her child, should turn a deaf ear to the tales of woe, which friends too often delight to communicate, and should endeavour to preserve a cheerful and equable frame of mind, which is the only condition justified by the facts. She ought early in the months of her pregnancy to determine who shall be her medical attendant, and if she has any doubts or misgivings, or really wishes advice on any particular point, she ought without hesitation to go to him for it. If she has made even an ordinarily good choice, she will find her doubts removed, and her mind quieted, and will have an authority, to whom the advice of her friends can be submitted, and by whom it can be, without offence to them, satisfactorily disposed of.

Much may be done, by pursuing a regular method of living, to make the months pass in comparative ease and comfort. To aid in accomplishing this, some general directions will be given.

Food.—There is no special diet suited more than another to the pregnant state. The rule is plain nourishing food at appropriate and regular intervals. Very rich and highly-seasoned dishes are undesirable. In some cases there is a craving for certain articles, and provided they belong to the nourishing class of foods, the yielding to the craving in moderation is not to be denied; but in a few cases the craving is for unwholesome and nauseous substances. This is to be considered as morbid, and ought to be held in restraint not only by the person herself, but also by all who surround her.

Stimulants are neither necessary nor desirable in ordinary circumstances. It is not denied that they are often useful and perhaps also necessary, but the usefulness and necessity ought to be judged of by the medical attendant and not by the patient herself or her friends.

Clothing should be carefully adapted to the varying condition of the person, and should never be at any part tight fitting. Enough has already been said on the subject of corsets (p. 611), but in the pregnant condition their evils are much increased. "The Romans were so well aware of the mischief caused by compression of the waist during *gestation*, that they enacted a positive law against it; and Lycurgus, with the same view, is said to have ordained a law compelling pregnant women to wear very wide and loose clothing."

In the later months a bandage, broad in front and narrow behind, if properly fitted so as to support the womb without compressing it, will give much comfort. It should be put on while the person lies in bed on her back, and should be removed at night.

Exercise.—During the early months of pregnancy there is difficulty in taking walking exercise, because the womb sinks down lower than usual on account of its increased weight, and makes walking attended with discomfort if not actual pain. When the womb has risen upwards, owing to its requiring more space, this difficulty becomes less, and thus during the middle months of the nine, exercise is more pleasant and less fatiguing. Towards the end of pregnancy it becomes increasingly difficult because of the size and weight, and also because the joints become lax, in preparation for the period of delivery. Gentle, regular, and moderate exercise, obtained by walking, should, however, be persisted in throughout the whole period, never, however, so as to cause pain. The patient must not allow her inclination to be completely at rest so to overcome her as to prevent her obtaining the slight change and beneficial stimulus which a short period in the open air will secure to her. In particular the desire to avoid the public gaze ought not to keep the person completely indoors for the last month or two of pregnancy, as it too often practically does. Gentle carriage exercise need not be forbidden, but jolting over rough roads is plainly likely to be injurious. Lengthened shopping expeditions and such like are too frequently the cause of miscarriage during the early months as well as during the later months. While more rest is needed than in the non-pregnant state, an increased amount of rest ought not to be permitted to lead on to idle, lazy, and indolent habits.

Bathing.—Baths should be taken in moderation, extremes of heat and cold being carefully avoided.

The Breasts require some attention. Pain, swelling, and tenderness of the breasts are among the early signs of pregnancy, as we have seen, and require no special attention. But if the breasts are small and ill-developed, and the nipples pressed in, as they may be by the pressure of stays, trouble after delivery may be saved by drawing them out with the aid of a breast-pump, or the ordinary breast-exhauster, or by manipulation with the fingers.

Should the nipples be tender, the best means of toughening them is by the use of the tannin and glycerine of the chemists. The use of alum and whisky is too apt to make them hard with a tendency to crack.

Medicine.—It is a matter of the greatest moment, for the comfort of the patient, that daily movement of the bowels be obtained. This ought if possible to be secured by diet—the use of oatmeal, fruits like figs, prunes, stewed apples, &c. Sometimes medicine is needed, and many take a dose of castor-oil at regular intervals. It is comparatively safe, though nauseous, but it often occasions "false pains" near the termination of the pregnancy. The writer is in the habit of recommending not castor-oil but Hunyadi Janos mineral water. If there is any doubt at all of obtaining daily an easy and sufficient movement of the bowels, he advises the mineral water to be taken each morning before breakfast, in the quantity the patient finds suits her, and it ought to secure a gentle motion, without purging, after the lapse of an hour or two. The average quantity is a claret-glassful, but the patient should begin with a small wine-glassful and go up, if necessary, till the suitable quantity is found. It should be then regularly taken. It is a simple remedy, practically incapable of doing harm, and its use he has found, over and over again, to conduce greatly to the health and comfort of the patient. No other medicine should be employed without proper advice.

PREPARATIONS FOR CONFINEMENT.

The Nurse.—The selection of a nurse should not be left to a late stage of pregnancy. As soon as a woman knows or believes herself to be pregnant she should take steps to secure a properly trained nurse.

In these days there is no difficulty in securing a good nurse, as the most of them hold certificates of having received training. On the whole a nurse is to be preferred who is connected with some nursing institution, because there is thus some guarantee of her character and qualification, apart from her certificate.

Many first-class nurses, however, after a period of connection with an institution, look forward to become private nurses. Their record ought to enable one to judge of their ability.

A young and active woman is to be preferred to the stout and elderly person, who is apt to be always airing her experience. The writer has always a doubt of the nurse who comes with a large statement of her wide experience. If a doctor is to be in attendance, the nurse's experience is not required; what is required is that she be scrupulously cleanly and tidy; that she be active, accurate, and punctual in her duty, moving about quietly and without fuss; that she carries out her instructions intelligently, and is able to make a reliable report to the doctor of the condition of her charge.

The nurse should be able to take charge of the patient's room, keep it tidy, and attend to its heating and ventilation, from the time her duties have really begun by the occurrence of labour.

The cleanliness and tidiness of the mother's bed and the mother's person are her business also.

She brings the mother her meals, and frequently, when the meals are such simple things as hot milk, gruel, &c., she prepares them also.

She has sole charge of the infant, its bathing and clothing, its feeding, its carrying out, and its bed. All the utensils needed for the lying-in room—urinal, bed-pan, washing-basin and washing materials, diapers, napkins, &c.—she is responsible for.

In a house of some size, where there are servants, and specially where there are several servants, much of the real manual work will be done for her by one or other of the servants. Thus the mother's meals would be brought, properly arranged on a tray, by a housemaid, and handed over to the nurse; the washing of utensils, napkins, &c., would be done by an under maid, and so on. But the fit nurse is able to do all these things, if the need arises, and is personally responsible to the doctor for them all being properly done. Most doctors will admit that the best nurses they have had have been seen in working-men's houses, have been able to do all things necessary for the patient with their own hands, and have been willing to do it, when the necessity exists.

But the nurse is never to be put on the same footing as an ordinary servant. While a good nurse will only show her fitness, when in a small house with little help, by doing many things not strictly within her province, in a larger house, with plenty of help, her superior position must be recognized from the outset. It is one of the features of a really good nurse that no difficulty arises between her and the servants of the household, and that she is able to get everything done that is proper without friction or murmuring. The nurse, wherever possible, should sleep in a room opening off the patient's; she should not be expected to take her meals with the servants, they should be served to her apart.

When it is necessary for her to sleep in the same room as the patient, it should never be in the same bed. An arrangement ought always to be made to permit the nurse to be off duty for one or two hours daily, to permit her getting fresh air and a respite from work.

No good nurse will ever talk about her experiences to her patient, or relate tales of distress and difficulty.

No good nurse will pit her experience and knowledge against that of the doctor.

If, unfortunately, the doctor should not leave full and adequate instructions on any point, the nurse should ask for them, and if it becomes necessary for her to act without instructions, she should do so quietly and without calling the patient's attention either to the doctor's omissions or her own cleverness in doing without them. The knowledge of either of these two things would be disturbing to a great many patients.

No first-class nurse is noisy; she does not bang the door when she goes out, nor yet does she continually leave it creaking ajar; she is not continually knocking against the furniture; she does not mend the fire with much rattle of fire-irons at any time, still less when her patient is asleep.

No nurse should be engaged who expects any alcoholic drink to her meals or at any other time.

Difficulties will be prevented if the patient, when engaging the nurse, lets her know exactly what the size and arrangements of her household are, and to what extent the nurse can depend on assistance. This is easily done if the nurse calls on the patient at her own house, and sees the room, &c., before the engagement is made.

The Lying-in Room, as the room is called in which the mother expects to spend the time of her confinement during and after delivery, should be selected some time before the event is due.

It should be as large an apartment as is available, well-lighted, with a fire-place. That the chimney is clear, and that the fire will burn properly, should be made certain. The windows should be capable of opening above and below. If the sashes are loose, so that the window rattles in its frame, a little wedge should be attached to the window to prevent this. Such little wedges are now purchasable for a copper in any ironmonger's.

The room should be so shaped that there is a space in which the bed can stand out from the wall, without being in the draught between door and fire or window and fire.

If the floor is well made and jointed, it would be best bare, except for a rug here and there, which can be lifted and carried outside for shaking. The floor, in such a case, would be thoroughly scrubbed in anticipation of the confinement. If the room is carpeted a very thorough brushing is needed beforehand.

Hangings of any kind are an abomination in the lying-in room, harbouring dust. All hangings should be removed wherever possible; all that is needed is something of the nature of a fresh muslin curtain to shade the room in bright sunshine.

Bare walls, free of brackets and heavy pictures, are also desirable, and it would be well to have them brushed down in time.

The less furniture there is in the room the better. A plain wooden table, covered with a white washable cover, and two plain chairs are sufficient. A chest of drawers, which have been cleared of all accumulated rubbish, and which are devoted to the materials and clothing for mother and child, would be useful. A plain or marble-covered wash-stand, with a plain water-jug and basin, a soap-dish, a water-bottle and tumbler, a dish for nail and tooth brush, these are also permissible. But the water-jug must have a wide enough mouth to permit the hand to get in with a brush to cleanse it thoroughly inside, and the other dishes should also be of size and form to permit of thorough cleansing outside and in. The water-jug ought not to be converted from its proper use to a receptacle for dusters, soiled handkerchiefs, and sundry odds and ends, but should daily be washed out and filled with fresh water. If the wash-stand has small cupboards, they should be washed out and kept empty. A pedestal for a chamber should be banished from the room. No other furniture should be in the room if it is possible to avoid it. If heavy wardrobes or such articles can by any means be moved elsewhere, this should be done well before the expected date.

Furniture, it must not be forgotten, occupies air space, of which there cannot be too much for a woman who is to be confined there day and night for two or three weeks.

All hangings and ornaments should be removed from the mantel-piece, and all the knick-knacks, that harbour dust and dirt, from any dressing-table that is allowed to remain in the room.

If in the house there are two rooms opening into one another, and the domestic requirements do not prohibit it, these should be selected, and one given up to the nurse. As far as possible the nurse should make all her preparations, and arrange that the child shall be washed and kept there, except when at the breast, to give the mother as much quiet as possible. All these arrangements should be made in good time, lest the birth occur sooner than is expected and everything be found in confusion.

The Bed should be a single one if at all possible. It should stand out from the wall so that both sides can easily be got at, and in such a position that the window does not face the patient, who should be able to lie on one side with her back to the light.

The position of the bed should also be such that, the patient lying on her left side, the medical attendant can be seated at the bed-side in front, and will have the patient's back towards him and the patient's head on his left hand, while the light from the window is full on the front of the bed, or sideways on the front and foot. The more plain the bed the better—of enamelled iron or wood, or of brass,—the workmanship as simple as possible.

It should be without hangings or valance. Nothing should be permitted under the bed at any time, for however brief a period.

If the bed is new, a wire mattress is probably supplied with it, and a hair mattress on this is sufficient. If the bed is old and tends to sag in the middle, this may be corrected by a straw mattress, on the top of which the hair mattress rests.

But the history of these straw and hair mattresses should be known. If they are not quite new, the patient should make sure they have not been used in any case of illness of doubtful character.

To prevent sagging, in an old bed, wooden laths across the bed under the mattress may be used.

Bolster and pillows should be free of suspicion, like the mattress. Blankets and sheets should have been washed, in anticipation of their use, and should have been kept aside till needed, so that everything is perfectly fresh and clean.

The patient, aided by the nurse, should take pains, on the eve of the confinement, to go over everything needed and make sure that everything is ready and clean.

Once the labour has begun it is extremely undesirable that anything in the shape of extra pillows, sheets, cushions, &c., should be brought in, and more particularly that anything should be borrowed and brought in from a neighbour in a hurry. Infection may thus be carried.

A foreseeing nurse will anticipate all possible requirements and provide for them. She will even make sure that the extra pillow to put between the patient's knees as the labour progresses, and the stool against which she may press with her feet, are at hand and in a condition fit for the purpose.

Special Bed Requirements.—The lying-in bed is made in the ordinary way, with certain additions. These special requirements are:

A rubber or mackintosh or waterproof under the under sheet.
A rubber or macintosh or waterproof on the top of the under sheet.
A folded sheet or blanket on the upper waterproof.

The folded sheet or blanket is so placed that the patient lies on it, and it receives all discharges from the womb during labour. It must, therefore, be large enough to prevent anything escaping on to the under sheet. The top waterproof is immediately under this folded sheet or blanket, and should project with a considerable margin beyond the sheet on every side. After the labour is over, the folded sheet and its waterproof are rolled up and withdrawn from under the mother and enclose within them all discharge, so that there should be no soiling of the under sheet. The waterproof that then remains under the under sheet is only a further protection to the bed, lest anything should have escaped on to the under sheet. But where expense is a serious consideration, this under waterproof can be done without.

"**Accouchement Sets**" are now obtainable at all druggists'. They consist of two thick squares of wood-wool, with a dozen or so of wool diapers or sanitary towels. One of these wood-wool sheets—the longer of the two—is used during labour, instead of the folded sheet or blanket, is removed and burnt after labour, and is replaced by the smaller one.

As much care must be taken that the folded sheet or blanket is perfectly fresh and clean as with the more permanent bed-clothing. Soiled garments must never be used for this purpose.

If the cost of the articles does not need to be taken into account, the under waterproof ought to be a large square of thin rubber; the upper waterproof should be broad enough to extend in the bed from the waist to the knees of the patient, and should reach from one side of the bed to the other, overlapping both edges. On the top of this should be a large-sized wood-wool accouchement sheet, or an ordinary sheet or half-blanket may be used, folded lengthways and laid across the bed, just overlapping the front, and the excess rolled up on the other side. As the labour progresses, and this sheet becomes soiled, it is drawn through under the patient, the soiled part being rolled up on itself, and thus a fresh portion is always under the patient. But the accouchement sheet is to be preferred, because it sucks up or absorbs the discharge and does not permit it to flow away over the bed.

These things—waterproofs, sheets, &c.—should be obtained in time, before the confinement. They should be removed from the paper in which they are usually wrapped and each rolled up separately in a thick towel, the sides of the towel folded in on them and the end pinned off, and they should be placed away in a drawer reserved to themselves. If shoved away anywhere, in the paper in which they are received, the paper will certainly become torn and they will get dusty and stained.

Gamgee, a specially prepared absorbent wool, made in thick sheets held by gauze on each side, is an excellent substitute for accouchement sheets, sanitary towels, &c. It is obtained in 1-pound rolls. A piece of this of full breadth and of requisite length should be cut for laying on the upper waterproof, other pieces suitable as to length and breadth for napkins for the mother should also be cut, and another lot of pieces cut in 3-inch squares should be prepared for sponges. The nurse should cut these beforehand: two or three pieces for sheets, a dozen or so for diapers, two or three dozen squares, and should be kept each lot rolled up securely in its own towel. In another towel should be rolled up 1 sheet, 2 or 3 diapers, and 4 or 6 squares, so that the nurse needs only to undo one towel to get what she needs on any one occasion, and does not need to expose her whole stock every time she wants a diaper or a square.

Sponges must never be seen inside the lying-in room. They are, as a rule, nests of foulness. The squares of gamgee, noted in the last paragraph, are available for all purposes. Specially must the mother's genital organs never be touched by a sponge, either just before, during, or in the days immediately succeeding labour.

The squares of gamgee are available for every purpose, wet to sponge with, and dry to dry with.

Utensils for the Lying-in Room.—Besides the articles already named, there should be at hand a drinking-cup, a measure-glass, a bed-pan of the slipper form (Plate XXXVII.), a china or enamelled slop-pail, a rubber or other hot-water bottle. The cleanliness of these the nurse should herself directly see to. They should never be allowed to lie soiled. At the earliest moment slops should be carried from the sick-room. Under no circumstances should they be pushed under the bed, out of sight, lest they be forgotten. At the earliest moment they should be carried from the room, the vessels immediately washed, and, in the case of the bed-pan and slop-pail, rinsed out with some disinfectant, such as chloride of lime solution. The wash-hand basin should be cleansed with a brush and antiseptic solution, such as permanganate of potash, lysol, or carbolic. They should then be dried and brought back perfectly clean and ready for use.

Instruments needed by the Nurse.—The nurse requires the following instruments:—

(1) An enema syringe, with bone nozzle and vaginal tube to slip over it, for douching purposes.
(2) A clinical thermometer.
(3) A glass and pure rubber catheter.

While the nurse should have these instruments herself, it is much better that the patient should have her own **enema** rather than that one should be used for her which may have been employed for many other persons. The enema should, but for the nozzle and vaginal piece, be of pure white rubber. It will then stand boiling, and will thus be made quite free of possible infection, be, that is, **aseptic**. To boil it, a perfectly clean pot is used, pure *cold* water is put in, with a tea-spoonful bicarbonate of soda to each pint of water. The enema is completely immersed, squeezed several times to fill it completely, the lid is put on, and the whole boiled for 2 or 3 minutes. It is then removed, and immersed before use in, and completely filled with, a solution of carbolic acid (1 to 20) or lysol (a tea-spoonful to a pint). If the enema is to be put away, ready for use, it should be lifted out of the pot, emptied of water, and wrapped up in a perfectly clean towel.

If any of the parts of the syringe are made of vulcanite they are apt to be injured by boiling. In such a case immersion in 1–20 carbolic should be employed, the syringe being filled with the solution.

The Catheter can be boiled so quickly that it should be so treated just before use, and then immersed in the carbolic solution, out of which it should be lifted and used wet.

The Clinical Thermometer is described on p. 38.

A douche may be given with the enema syringe, but a special apparatus is best (see Plate XXXII). It should be made aseptic in the same way as the enema. The half-ring of vulcanite to rest on the edge of the vessel containing the douching fluid will not stand boiling.

Toilet Articles in the Lying-in Room.—If the cleanliness of the lying-in room is to be complete, it must extend to the person of the mother, and of the nurse, and they must, therefore, see that all toilet articles used by them are clean and kept clean.

Hair-brushes and Combs must not be overlooked in this connection. All old hair-pins should be discarded, safety-pins and common pins should be fresh.

Scissors.—A special pair should be kept in the room, and should be purified by boiling, as noted below.

The Nail-brush is of the utmost consequence. The nurse should have a perfectly new one—they can be bought for a few coppers—for herself. It should lie in a small bowl or glass

PLATE XXXII

DOUCHES AND ENEMA SYRINGE

The upper part of the plate shows a nasal and a vaginal douche.

In each case, if the vessel containing the douching fluid be kept higher than the outlet of the tube, once the tube has been filled it will go on running till the vessel is empty. After the tube has been filled, therefore, the flow is stopped or allowed to go on by the movement of a tap.

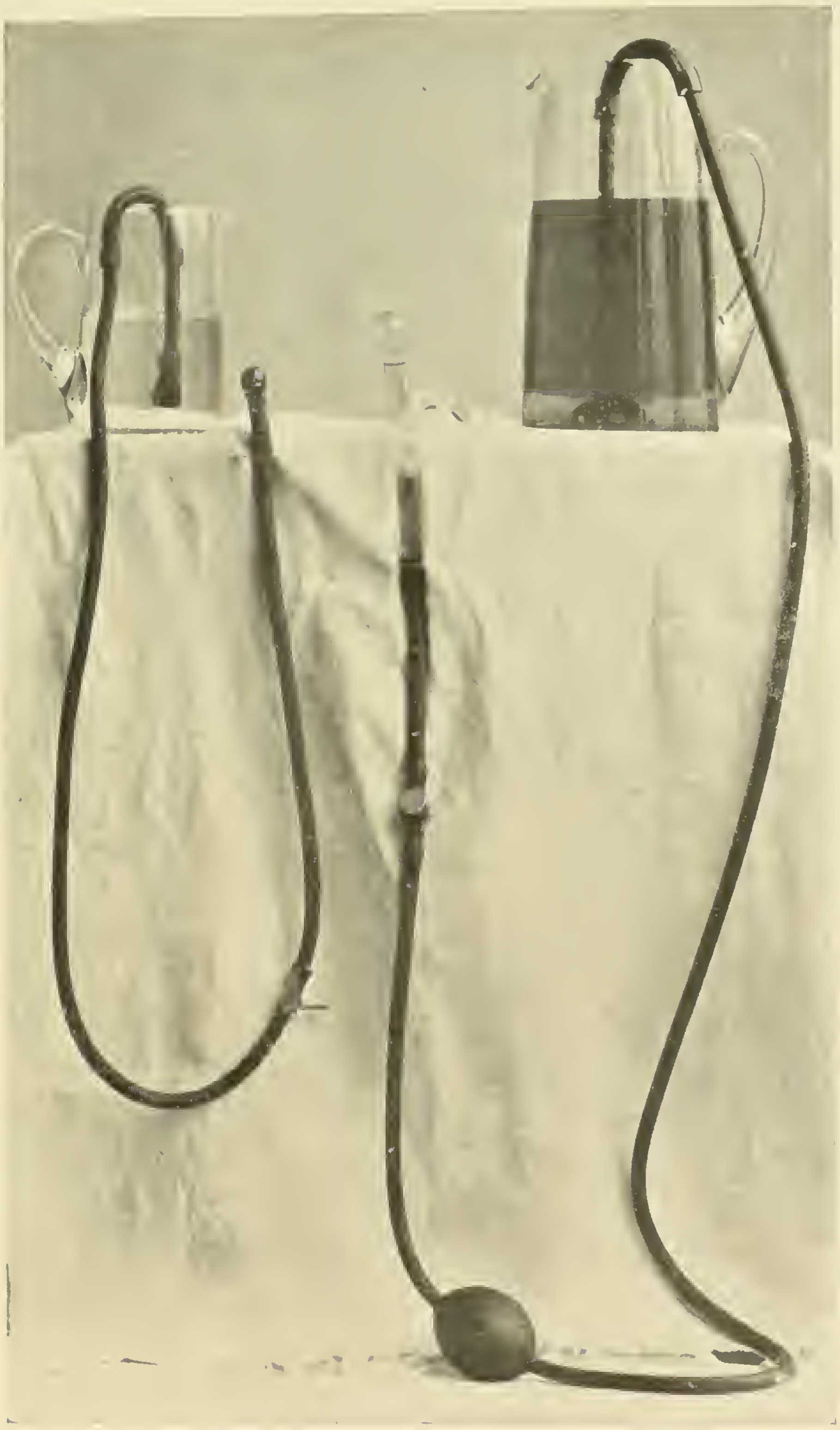
The vaginal douche shows a French tap of vulcanite; in the nasal douche the tube passes through a spring arrangement, in which the movement of a lever compresses the tube.

To fill the tube a ball may be interposed in its course. If the tap be closed and the ball then compressed the air is expelled through the fluid. When the ball is released, it expands by its elasticity and so sucks in fluid. If now the tap be turned the water will flow from the outlet continuously.

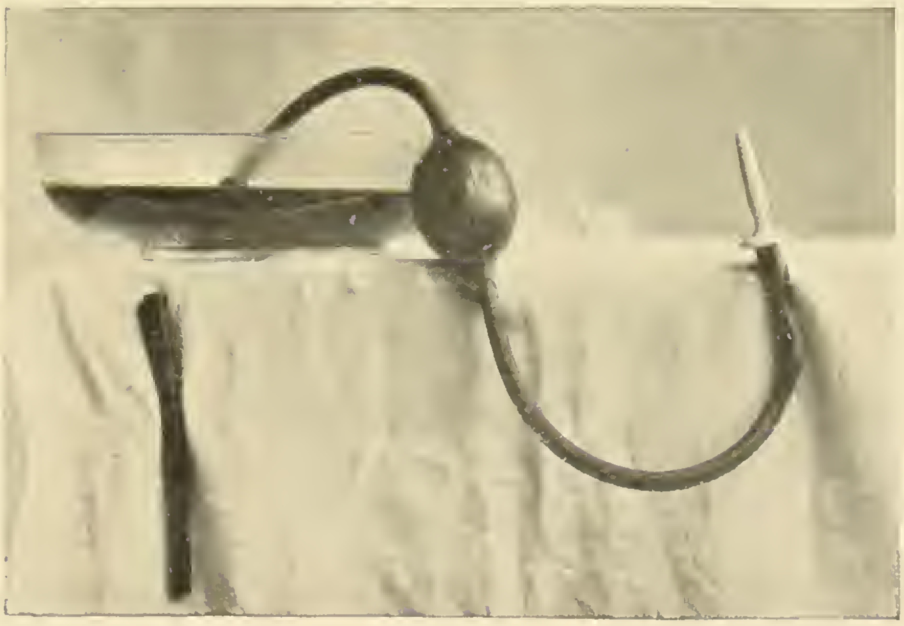
A similar small ball might be on the nasal tube. In the case shown in the plate, the tube would have to be filled at the outset by suction with the mouth at the outlet.

The lower portion of the plate shows an enema syringe. Refer to p. 592.

DOUCHES AND ENEMA SYRINGE



Nasal Douche. Vaginal Douche.



Enema Syringe
An additional rubber nozzle is shown below the basin,
which can be pushed over the bone one

finger-bowl, on the table or wash-stand, immersed in a solution of carbolic acid, 1 ounce to 20 of water.

Antiseptics are a necessity in the lying-in room—

(1) for the disinfection of the mother.
(2) ,, ,, ,, nurse's hands.
(3) ,, ,, of all utensils used.

For the first two purposes the antiseptics in most common use are—

Corrosive Sublimate (Perchloride of Mercury),
Carbolic Acid,
Carbolized Vaseline,
Lysol,
Creolin,
Solution of Boric Acid,
Izal,
Solution of Permanganate of Potash (Condy's Fluid).

For the last purpose crude carbolic acid or chloride of lime solution should be used.

A full description and discussion of these substances will be found in Vol. II., p. 446, and subsequent pages.

Corrosive Sublimate is now obtained of druggists in tabloid form, usually coloured blue, to prevent mistakes, as it is a powerful poison. Tabloids may be obtained of such a strength that one dissolved in a pint of water makes a solution of 1 in 4000, and another stronger tabloid makes 1 in 1000. The former is the strongest that should be used for a douche, the latter may be used for the hands or external parts. It should be noted that metallic vessels or instruments are injured by it.

Carbolic Acid, pure, may be used 1 ounce to 3 pints of water (1 in 60) for douching or lotion, 1 ounce to 2 pints (1 in 40) or 1 ounce to 1 pint (1 in 20) for hands and instruments. Hands should first be thoroughly washed, and scrubbed with soap and water and a nail-brush, the nails trimmed, and all material removed from under the nail; they should then be thoroughly cleansed from soap in fresh running water, and then they should be immersed completely in a solution of carbolic acid (1 to 20). The sleeves should be rolled up when this is being done, and the washing and scrubbing done up to the elbow.

When the mother is to be sponged, or an examination made, the hands are not dried, but used wet out of the warm carbolic solution. The fingers, if an examination is to be made, may be smeared with carbolized vaseline or carbolic oil.

Lysol is one of the best of antiseptics for lying-in room purposes. For hands and arms the same process is followed as noted above, and the hands are finally immersed in a solution of 1 tea-spoonful of lysol to 1 pint of warm water. This is a soapy solution, and therefore carbolized vaseline or oil is not needed with its use to lubricate the fingers. For sponging the external parts of the mother, or for instruments, the same strength is used; but for douching, 1 tea-spoonful to 2 pints of water is strong enough. A stronger solution smarts severely.

Creolin is useful, 1 tea-spoonful to 2 pints of water used in the same way as lysol solution.

Izal, a tea-spoonful to 2 pints of water, may be used.

Boric Acid is not so useful as the above (see Vol. II., p. 447).

Chloride of Lime solution for utensils (see p. 516).

It must be noted that all the vessels in which such solutions are placed for use must be thoroughly washed and scrubbed before the solution is put into them. There is little use employing an antiseptic solution if the basin it is put into is a soiled or dusty one, and it is extremely silly carefully to wash a basin and then dry it before use with a soiled towel, or give it a hasty wipe with a dirty apron.

The Mother's Preparations.—The mother, looking forward to her confinement within a week or two, should be particularly scrupulous about the cleanliness of her person, by frequent bathing or sponging of the whole body. Very hot baths are to be avoided; they should be just comfortably warm, and the bath is best taken just before going to bed.

It is well also to cut short the hair around the parts concerned in labour.

The bowels should also be specially attended to. A full dose of any opening medicine is liable to bring on labour prematurely, or bring on an attack of false pains. It is better, therefore, for the patient to take daily just such small doses of opening medicine as she finds sufficient gently to aid the daily movement. For this purpose nothing is better than a nightly dose of castor-oil; from a half to one tea-spoonful will usually be sufficient for the purpose. It may be found better to take it in the morning, or to take an even smaller dose morning and night. If the mother begins to do this two weeks or so before the expected date, she will find it add enormously to her comfort during her confinement. Instead of castor-oil, a small morning dose, half to one wine-glassful, of Hunyadi Janos or similar aperient water may do well.

As soon as the mother becomes aware that labour is about to begin, having seen that everything is ready in the room, she should do any sponging, arranging of hair, &c., necessary, and put on her bed garments; but she need not yet go to bed. With stockings, slippers, and a gown over her night-clothes she may await further progress before going to bed.

The Nurse's Preparations.—If the advice given in preceding paragraphs has been followed, everything will be in order and at hand. The fire will be lighted in the lying-in room, the bed prepared, and, if necessary, warmed. The table and wash-stand covered with a fresh white cover or towel. The wash-hand basins will be washed again and scrubbed, dried, and set ready, covered from dust with a clean towel. Plenty of water will be boiled. The bed-room jug will also be scrubbed anew, thoroughly rinsed, and filled with boiling water, then covered with a towel and left to cool. More water will be set to boil. Utensils will be set in their proper place. Material for diapers, binder, pins, thread, dusting-powder, antiseptics, will all be placed at hand, but kept covered. Any extra clothing will be got ready, the child's clothing set out before the fire on a screen, and so on. When at length the patient goes to bed, the nurse should without further delay secure that the mother's external parts are free of any septic material, by washing first with soap and water and then with carbolic acid (1 to 20) or lysol (a tea-spoonful to the pint). In doing this she uses the squares of gamgee, already noted, both to bathe with and to dry (see p. 634).

By the time the medical attendant arrives, everything should be in order, and the nurse should be ready with hot water and soap for his hands, and with a basin of lysol solution for the same purpose.

Unless she is specially ordered by the medical attendant, the nurse should never make what is called a vaginal examination or a digital examination, that is, an examination with the forefinger of the right hand in the patient's genital passage to determine the position of the oncoming child. If she ever does so without orders she assumes a grave responsibility.

If she ever does so without thoroughly aseptic hands the risks of infecting the mother are immense. There is no possible doubt this is the cause of many of the cases of child-bed fever. No emergency whatever ever justifies such an examination without the hands being first thoroughly cleansed and soaked with antiseptic solution. If such an examination has to be made, the routine that must be followed has been already noted (p. 635), but the matter is so important it may be again referred to.

1. The sleeves are to be rolled up.
2. The nails are to be trimmed and cleaned under the edge.
3. Hands and forearms up to elbows are to be washed with soap and hot water, and scrubbed with a nail-brush.
4. Fresh hot water is then to be used to remove the soiled soapy water.
5. Hands are then to be steeped, and arms laved, in a hot solution of lysol (a tea-spoonful to a pint) for several minutes.
6. The hands are not dried. The basin containing the lysol solution should be set at the bed-side on a chair, a clean towel being laid on the chair and the basin set on it. The clothes over the mother are then arranged, and when all is ready the nurse once more steeps the hand to be used in the lysol solution and then carries it straight from the solution to the mother's external parts, which have also been bathed with antiseptic solution as described.

NOTE.—The nurse will note that it is in vain one washes the hands and soaks them in an antiseptic solution, if on the way to the bedside something is touched which is not aseptic, a door handle, for instance, or a chair back. Between the lifting of the hand out of the antiseptic solution and the contact with the mother nothing should intervene.

LABOUR AND ITS MANAGEMENT.

THE STAGES OF NATURAL LABOUR.

The First Stage of Labour.—Natural labour is the process by which the child is expelled from the womb and born into the world. It occurs at the end of the ninth calendar month of pregnancy, or, as has been already mentioned, about 280 days after conception. It probably begins at the time when a monthly illness would have been due, counting such illness as recurring every twenty-eight days, that is to say, at the time when the tenth monthly illness from the time of conception would have become due.

As we have seen, the womb is composed largely of muscle. As pregnancy advances it becomes greatly enlarged to make room for the growing child. Its walls also become greatly increased in thickness, and the muscular fibres become increased not only in number but also in size. The chief force in labour is the contraction of these muscular fibres. The fibres are so arranged in the walls that when they contract and shorten they tend to diminish the size of the womb and of its cavity, and thus act in the direction of squeezing out of the womb its contents. The walls are so strong that when they contract in this way they exert a very great force, and are thus able to overcome very great resistance to the expulsion of whatever the womb contains. The amount of resistance will depend on the bulk of the contents —on the size of the child—and on the width of the passage through which the child has to pass before reaching the outside. The first resistance, however, occurs at the mouth of the womb, which is closed, or at least not much wider than to admit the passage of anything thicker than an adult's finger. The child can, therefore, make little advance along the passage till the mouth of the womb has been sufficiently dilated or stretched, and this opening up or dilatation of the mouth of the womb is, accordingly, the first thing to be accomplished in the labour process. It forms **the first stage of labour.**

It has been already mentioned (p. 625) that the child is inclosed in a bag of membranes, floating in a liquid (the waters), having a cord attached at the navel by which it is connected with a mass called the placenta or after-birth (p. 624) attached to the inner wall of the womb, by means of which union with the mother is maintained. By the contraction of the muscular walls the bag of membranes, with its contents of waters and child, is pressed on and forced in the direction of least resistance, that is, against the mouth of the womb. The mouth being slightly open, the membranes and their contained fluid bulge into the slight opening, and are a very active agent in widening it. Sometimes the mouth of the womb is rather rigid, and the force pressing the membranes into it is so great that the pressure of the fluid bursts them, and a gush of water takes place—"the waters are broken," as the phrase is. The part of the child's body that is directed downwards —usually the head—is then pressed directly against the mouth of the womb, but it being larger, and not able to insinuate itself into the small opening as the bulging membranes did, dilates it much more slowly, and the labour is all the more tedious. During the first stage of labour, then, it is desirable that the membranes should remain unruptured, and that the "waters" should not escape.

It is the contractions of the muscular walls of the womb that occasion the pain characteristic of labour. They are not continuous, but last only a brief period, so that there are periods of pain followed by periods of freedom from it. The intervals of rest prevent exhaustion of the muscular walls, and also of the mother, and at the same time permit the mouth of the womb to be gradually and gently opened up without risk of injury, while the child also is allowed an interval to recover from the compression which, in the later stage of labour, each contraction exerts on it. The pains during this first stage are of a cutting or grinding character, and are usually trying to the mother, because she feels as if no progress were being made by them. She is often on this account irritable and restless under them, frequently changing her position and uttering complaints. A considerable interval elapses between each pain in this stage, perhaps twenty or thirty minutes at first, but the interval gradually lessens as the opening up of the womb becomes more nearly sufficient, till towards the end of this stage they may be returning every five minutes or oftener. The pain is usually felt more in front. While this stage lasts, efforts of straining or pressing downwards do not render any assistance in opening up the mouth of the womb, and they ought not to be encouraged, since they throw away the patient's strength, which ought rather to be reserved for the second stage, when they are of great value. It is of advantage, however, for the patient to move about her room, and interest herself in some gentle occupation during the intervals of rest, rather than confine herself to bed.

The Second Stage of Labour begins when the mouth of the womb is sufficiently widened to permit each contraction of the womb—each pain—to urge the child through the opening and down the passage to the outside, and it ends with the birth of the child.

During this stage the bag of fluid is no longer a help, but rather a hindrance, and, therefore, it is proper for the attendant to introduce a finger into the passage, and when a pain occurs to press the point against the bulging and stretched part so as to burst through it. This permits the escape of the water and allows the advancing part of the child to come directly into contact with the walls of the passage, which it is best able to stretch.

The upper and inner end of the passage is formed of the bony rim of the pelvis, and is practically unyielding, so that the child in advancing through it must have its body compressed and moulded to permit of its passage. Were the pains constant the continued compression might be injurious to the child, and so the intervals of rest, though brief, are beneficial. The remainder of the canal is formed of soft and yielding structures, which the advancing part of the child stretches with more or less ease. But here again the periods of contraction, followed by intervals of rest, permit the parts to be stretched to some extent and then to be released from pressure. Thus the widening of the passage is accomplished gradually, and without risk of injury.

During the second stage the patient naturally fixes her body, bends the knees up towards the body and the head towards the chest, grasps something fixed with the hands, and, holding her breath, presses down. The pressure thus exerted by the walls of the belly greatly aids the process of delivery. During this period, therefore, the patient remains in bed, and the more quietly she lies, the more firmly she holds her breath while the pain lasts, and the more vigorously she presses down, the more speedy will be the termination of her suffering.

In a few cases, when the child is advancing with great rapidity, and the parts are being stretched too quickly and forcibly for safety, one does not permit the patient to have anything to grasp, and, instead of urging her to hold her breath and press down, one asks her to cry out, to refrain as much as possible from pressing down, and thereby to prevent the pressure by the walls of the belly.

The pains during the second stage are felt at the back, and the patient is much aided by someone pressing the back firmly with the palm of one or both hands.

Towards the termination the mother feels something pressing low down, and the bulging and opening out of the external parts indicate the near approach of delivery. The advancing part of the child appears at the external opening, which it widens as the pain occurs. With the interval of rest it retreats. When another pain occurs it advances further, stretches the opening still more, and with another interval again retreats. The child may seem just about to be born, when the pain ceases for a minute or two and it goes back again. This sometimes disheartens a mother somewhat, but it is desirable, for it permits the gradual widening of the opening, and diminishes the risk of tearing. Finally, with a great effort, the first part of the child is born, the rest of its body quickly follows, and the delivery of the child is accomplished.

The Third Stage of Labour, however, remains. It consists in the expulsion of the after-birth, with which the cord passing from the child's navel is connected. It is not usually accompanied by much pain, and occurs within from five to thirty minutes of the birth of the child. It is often expelled from the womb when the child is born, and lies in the passage for a little time, till it is removed by gentle pulling on the cord by the attendant, or ejected by contractions of the walls of the passage itself.

The after-birth is separated from the wall of the womb by its contractions. But with its separation blood-vessels of the mother are opened and a raw surface is left. From this, for an instant, blood escapes in considerable quantity, but is speedily checked by the contraction of the womb, which now becomes permanent, squeezing the mouths of the bleeding vessels together and thus closing them. Some blood remains in the cavity of the womb, which is reduced by the contraction to very small dimensions. It gradually oozes away as discharge. Any clots that remain do not escape so readily, and excite small contractions to get rid of them. These are the occasion of the **after-pains**. So that the more thoroughly the womb is emptied of all clots, after the separation of the after-birth, the fewer will be the after-pains; and they will be severe and troublesome for a day or two if any quantity of clots has remained behind. Usually after-pains are absent in a first labour.

The Duration of Labour varies naturally with the size of the child and the width and capacity of the canal through which it must pass, as well as with the age, vigour, and build of the patient. It is longer in first labours than in those subsequent, on an average twice the length. The average for first labours is roughly twelve hours, and for others six. The first stage occupies generally two-thirds of the whole time. At the same time it is not possible to gauge what is likely to be the time occupied during the later stages from that occupied by the first. For a labour which has begun quickly and gone on quickly for some time may become much slower as its termination approaches, or the reverse may occur.

THE POSITION OF THE CHILD IN LABOUR.

The Attitude of the Child.—In the womb, even in the early months of pregnancy, the child usually bends forwards, and in the later months the head is bent forwards upon the chest, and the thighs bent upwards to the belly, the knees and elbows also, and the arms crossed and folded over the breast. This is called the **attitude of the child**, and it suits best the cavity in which it is placed.

The Presentation of the Child.—It is usually the head that is directed downwards towards the mouth of the womb. At full time this is the rule in 97 per cent of cases. But other parts of the child may present themselves first at the mouth of the womb, and the word **presentation** is used in referring to the part of the child that thus offers itself first at the opening of the womb.

Head Presentations, in which the head of the child advances, occur, as already mentioned, in 97 out of every 100 cases.

Breech Presentations are those in which the other extremity of the oval, which the child forms in the womb, is in advance, the buttocks that is to say. This occurs once in every 45 births.

Cross or Transverse Presentations are those in which the child lies across the mouth of the womb, and so a shoulder or hand, &c., descends first. These are happily rare, for they are very unfavourable.

The Position of the Child.—While **attitude** expresses the relation of the child's trunk and limbs to one another in the womb, and **presentation** expresses the part of the child which offers itself first at the outlet of the womb, the word **position** is technically employed to express the relation which the child bears to the body of the mother. The child's head is usually downwards, towards the outlet of the womb, and with the head downwards the child's back may be towards the front, that is, towards the mother's abdominal wall, or the front of the child may be towards the mother's abdominal wall.

With the child's head downwards, and its *back* in front, it is the back part of the child's head which presents itself at the outlet of the womb, and *the face is looking backwards.* But with the head downwards and the *front* of the child towards the mother's abdominal wall, the back of the child's head still presents itself first at the outlet of the womb, but *the face is looking forwards.*

The child's position in the womb is never, however, exactly in the middle line, with its back directly facing the mother's abdominal wall, or its chest directly facing the front. It lies, on the contrary, sideways, because it has thus more room, and thus the back of the child comes to be either to the mother's left side or to the mother's right side. In the same way, when the child's chest is to the front, it faces the mother's left side or right side.

The First Position.—When the child is head downwards, and its back facing the mother's left side, the back of the child's head will present first, and will be directed to the left, while **the child's face will be looking backwards**, and *to the right.* This is called **the first position.**

The Second Position.—When the child's back is to the mother's right side, the back of the child's head will present at the outlet of the womb, and will be to the mother's right, while **the child's face will look backwards**, and *to the left.* This is the **second position.**

The Third Position.—Similarly there are two positions when the child's *chest* is to the mother's front. In both of these the back of the child's head will still present at the outlet of the womb, but the child's face will be looking forwards. In one of them the child's face will look *to the left*, and the back of its head will be directed backwards, and to the mother's right. This is the **third position**, and is exactly the reverse of the first.

The Fourth Position.—On the other hand the back of the child's head may still present at the outlet, with the face looking forwards but *to the mother's right*, and the back of the child's head directed backwards, and to the mother's left. This is the **fourth position**, and is the reverse of the third.

The first position is the commonest, and occurs in 65 out of every 100 cases; the third position comes next in 20 cases out of 100, the second position in 10, and the fourth in 5 out of 100.

The child's head is downwards in 97 out of every 100 labours, and it is therefore unnecessary to consider here the odd 3 out of every 100 in which some other part of the child presents first.

Now we have mentioned these positions for a definite reason. If one pictures to one's self the child head downwards in the womb, its back to the mother's left side, and its face looking backwards, and to the mother's right buttock, and if one further thinks of the womb contracting to force the child downwards through the vaginal outlet to the outside, it will be understood what the first effect of the downward pressure will be. Suppose a child upside down, and the buttocks pressed on while something resists the advance of the head, the first thing that happens will be that the head will be bent and the chin pressed on to the chest. The back part of the head will thus be forced out of the womb first, and the head will come through, not broadside on, but lengthways, in a line from the back of the head to the chin. It will pass through more easily this way, and the child's head being still soft, and the bones not yet all united, it will be moulded gradually, and this moulding will make the child, for the time being, long-headed so to speak.

As the head progresses through the bony brim of the pelvis (see Fig. 24, p. 63) it gets down into the lower part of the pelvis, where there is more space, and as the pressure is renewed from above the head will continue to advance in the direction of least resistance.

While the child's head is at the brim of the pelvis, there is more room to pass in a diagonal direction than in a line straight from front to back, or from side to side, in the lower part of the pelvis, on the other hand, the greater room is from front to back. Thus as the head continues to advance, merely because it moves in the direction of least resistance, it tends to make a partial turn, till when it reaches the external opening the head has so turned that the face is looking directly backwards, and the neck is still strongly bent, chin towards chest. The first part to be born is, therefore, the back of the head, which comes out just below the pubic bones of the mother (see Fig. 24, p. 63). As the pressure continues from above outwards, the back of the head will bend upwards in front of the mother, and the child's face will sweep along the curve of the mother's pelvis behind, the face being directed straight back to the bowel of the mother, and the eyes, nose and mouth of the child will appear successively, directly in front of the outlet of the mother's bowel. When the chin of the child reaches the outlet, it will tend to be caught by the tightly stretched back edge of the outlet, but if at this moment the assistant places his hand on the back of the child's head, and slightly bends the head towards the child's chest, the chin will be released and will slip out.

Now at this moment, when the child's head and face are born, its shoulders will be passing through the brim of the pelvis; and if one thinks of the position of the child—upside down, its face looking directly backwards — it will be evident that its shoulders would be expected to lie right across the brim, its left shoulder to the mother's left side. But this, as already noted, is not the line of greatest room. As the pressure continues, and the shoulders advance in the direction of least resistance, like the head, they will also perform a turning movement till the child's left shoulder turns into the mother's left side behind, and the child's right shoulder into the mother's right side in front. Lower down in the pelvis, where the greatest room is, as stated, from front to back, the child's leading shoulder—the right—will like the head, turn till it is directed to the front, while the left is directed to the back. The head, being born and free to move, will indicate that this movement has occurred by the child's face turning upwards towards the mother's right thigh, the mother lying on her left side. When the leading, or right, shoulder of the child reaches the front of the mother, it is caught or detained by the bony arch of the pubis of the mother's front, and meantime the child's left shoulder sweeps behind over the same ground already traversed by the child's face, and is born first, the right shoulder in front immediately following, and the rest of the body quickly and easily thereafter.

There is nothing remarkable in these movements. If one pushes a somewhat flexible rod through a narrow curved passage, the rod, meeting resistance to its passage, in obedience to the pressure from behind, will twist and turn, following the curves of the passage. So the movements of the child through the passage obey the same mechanical laws, simply following the pathway of least resistance. When the energies of the mother are adequate, and no unusual obstruction or narrowing exists in the passage, the process of child-birth is largely a mechanical obedience to physical laws.

But when the energy of the mother is little and easily exhausted, the child exceptionally large, or the passage unduly narrow, difficulties arise, and help has to be rendered.

The usual form of help consists in slipping instruments, called **forceps**, into the passage and over the child's head, and by means of them pulling the head down during each labour "pain," and thus helping the effort of the womb to expel the child. It will be evident, however, that if this is to be done with the greatest degree of safety to the mother and child, and with the greatest degree of ease, it must be done by someone who can determine accurately the position in which the child's head is lying, and so adjust the instruments properly, and who is also, from his knowledge, able to say in which direction the head would naturally turn in its progress outward.

While, then, labour is in the vast majority of cases attended by little difficulty, and little interference is required, nevertheless the mother should always be attended by someone fitted, alike by knowledge, training, and experience, to recognize when assistance does become needful, and able to render it without delay.

THE MANAGEMENT OF LABOUR.

Parturition is the term applied to the process by which the offspring, brought to a certain degree of maturity within the body of the mother, is expelled therefrom, and enters upon a separate existence. A shorter and more familiar word for the same thing is **labour.**

It is a natural process, and in the vast majority of cases is best accomplished by nature's own unaided efforts, without any necessity of meddlesome interference. It is only now and again that interference is necessary or desirable. As, however, in nearly every case where interference is necessary, there is a particular period when it may be more easily and successfully employed than at another, a woman in labour ought to have from the beginning the services of a skilled attendant. If on examination he finds everything going on properly and naturally, it is a great comfort and encouragement to the patient to be told so; and if, on the other hand, he finds something that requires active interference, he can choose the best time for it, and is ready for the emergency. It cannot, however, be too strongly stated that the cases where interference is really necessary are not so common as is supposed, are indeed rare in proportion to the natural and unaided births.

Symptoms of Labour. — Several things concur to indicate that confinement is near at hand. By the calculation shown on p. 626 the patient should know approximately the date at which confinement should occur.

That the time is near is usually indicated by the fact that the enlargement of the abdomen is not carried so high. The patient one day becomes aware that it is much lower down; she walks, also, with less ease; her joints seem slacker, as indeed they are. As a matter of fact the enlarged womb, with the child, does settle down, and this often happens three weeks before the confinement occurs. As a result of the weight pressing down more on to the pelvis there may be some discomfort about the bladder, more frequent need to pass water; and the bowel also may suffer from the pressure. In some cases piles form and cause a good deal of annoyance.

False Pains.—The weight of the womb resting on the pelvic organs is also likely to occasion irregular pains, which may be mistaken for the commencement of labour, and are called "false pains," and they may indeed lead on to this. As a rule they pass off if the bowels be unloaded, and if the patient takes a good deal of rest.

While these symptoms suggest the approach of confinement, there is no means of definitely fixing the day or hour of its actual onset.

True Pains.—The real process sets in, as a rule, quite suddenly with the **true pains.** These are distinguished by their regularity in character and in recurrence. A woman in her first labour—a **primipara**, as she is called—may think, at first, the pains are those of colic, but she will soon notice that they come at regular intervals, perhaps every half-hour, and as time goes on the intervals gradually lessen. Each pain is also of a definite character; it has its period of gradul increase to a height, it lasts a certain time, and then it rapidly diminishes. The duration is from half a minute to a minute and a half, and during the interval it completely disappears, so that even when the interval is only a few minutes the patient may have snatches of sleep.

The Management of the First Stage of labour implies little. As has been already stated (p. 637), what is happening during this period is that the mouth of the womb is slowly dilating in consequence of the insinuation between its lips of the bag of membranes. Unless, therefore, the pains from the outset are coming with unusual rapidity and violence, the patient may go about, and occupy herself, if she pleases, setting things in order. It will be well, indeed, if she can do so.

As the dilatation progresses there will be a little oozing of blood, and much mucus is secreted by the glands of the vagina, so that a stained glairy discharge issues from the passage, vulgarly called **the show**.

During this stage the nurse is giving the finishing touches to her preparations. She has sent for the medical attendant; for at this stage a finger examination will show the position of the child, and enable him to decide whether the labour is likely to pursue a normal course. It will, perhaps, also enable him to decide whether interference may be necessary.

In anticipation of his arrival, the nurse should make the preparations noted on p. 636.

This stage lasts longer in the case of patients bearing the first child—**primiparæ**—than in those who have borne several—**multiparæ**. In the latter it may be as short as two hours; in the former it may go slowly on for several days, and it not uncommonly lasts for 24 hours; and the average is 15. The older the patient the slower is it likely to be.

Voluntary expulsive effort during this stage is valueless, and not to be encouraged.

Whatever nourishment the patient has during this period should be of a simple character: hot milk, hot tea, hot soup in small quantities —a tea-cupful—at the patient's own pleasure.

If the bowels have not been freely opened that day, the lower bowel should be cleared out by an enema, and the patient should make sure that the bladder is emptied.

Visitors should not be encouraged in the room. Apart from the fact that one has no control of their movements, and no guarantee of their being free of infective possibilities, their conversation is very often entirely unsuited to the mental state of the patient.

Management of the Second Stage.—This stage is often indicated by the "escape of the waters", but not necessarily so, as the membranes may rupture before labour sets in, making it very slow, and they may remain untorn till the head is born.

The occurrence of the second stage is best known by the altered character of the pains. They are less irritating to the patient, who now instinctively settles down, holding her breath, fixing her body by grasping something with the hands, and aiding the expulsive effort by pressing against some support with her feet.

At this stage, therefore, the patient should go to bed, having removed everything except her night-clothing, which should be well rolled up as high as the armpits, out of the way of discharge. To protect the bed-clothes, a garment should be put on, lightly fastened round the waist, and quite open behind, a kind of apron. A flannel petticoat, split right down behind, is very suitable, but it must be perfectly clean and fresh, having been thoroughly washed for the purpose.

The powerful expulsive effort the patient can produce by voluntary contraction of the abdominal walls is of great value at this stage, and is much helped by giving the patient something with which to fix her arms, a towel fixed to the head of the bed, for instance, and by placing a firm support, a stool, for instance, at the foot of the bed. These must be scrupulously clean, and ought to be arranged beforehand (see p. 633).

The pain has changed from the front and thighs, where it is mostly felt during the first stage, and is now chiefly in the back, low down, and much comfort is given by the nurse sitting in front of the bed, applying both hands over this region and pressing firmly during each pain.

The pains are also recurring with increasing frequency, and the intervals become very brief.

When the head gets down on to the floor of the pelvis the bulging of the external parts shows its presence, and the patient now begins to feel something pressing on the perinæum. It is at this time that a pillow should be placed between the knees to separate the thighs. Now also the external parts may be again cleansed with a piece of gamgee soaked with lysol solution. This may be repeatedly needful because of matter forced out of the bowel.

During the labour, drink, cold water, &c., is not to be refused, but, of course, ought to be partaken of only in moderate quantities. A warm cup of tea may be refreshing, but stimulants are to be given only by medical orders, and without such advice no drugs should be taken with the idea of terminating the confinement more quickly.

Just when the child is being born the patient should refrain as much as possible from severe pressing down, that the risk of tearing the parts may be diminished. It appears also that the common custom of placing the hand over the external parts to hold against the advancing head is more likely to lead to rupture than to prevent it.

In anticipation of the birth of the child, its clothing should be hanging before the fire, a bath, warm water, a clean sponge, and some good soap should be in readiness, also a pair of scissors, and two pieces of linen thread, each piece about a yard long, and twice doubled, with a good knot at each end, for the purpose of tying the cord. Some olive-oil should also be at hand.

As soon as the head is born, the attendant should pass the fingers up to feel whether the cord is round the neck. If it be, the finger should be able easily to slip it over the shoulder. One hand is then placed over the outside of the belly, and, grasping the womb, as it were, gentle pressure is to be made, following it downwards as it descends. The body of the child will usually be born within a few seconds of the head without any further aid, though gentle pulling may be made with one hand on each side of the head, if aid seems needed from threatened suffocation of the child or other cause. Rarely the membranes are not ruptured during labour, and the child is born still inclosed in them. They must in such a case be quickly torn, else the child will be suffocated. The child is said in such circumstances to be born with a "caul." This, of old, was considered a sign of good omen, and seamen used to seek to obtain the caul under the belief that it protected the wearer from death by drowning.

The average duration of the second stage in primiparæ is 2 hours, in multiparæ 1 hour.

Attention must now be diverted for a little from the mother to the child.

The Immediate Treatment of the Newly-born Child.—As soon as the child is born it should be placed in a position in which it may breathe easily, bed-clothes being kept off its face, &c., and mucus wiped from the mouth and nostrils with a square of gamgee. Usually the mere contact of its naked body with the air causes a gasping movement, followed by regular breathing and lusty crying. If this does not at once occur, it is ordinarily readily induced by suddenly blowing in the child's face, smartly patting it on the buttocks, rapidly rubbing the fingers up and down the sides of the chest, or dashing a small quantity of cold water on the chest. All these means, by irritating the nerves of the skin, stimulate the movements of breathing. In the meantime it is proper not to tie the cord or separate the child from its attachment to the mother. For if the fingers be placed on the cord, pulsation will often still be felt, indicating that the circulation in the afterbirth has not yet ceased, and there is thus the possibility that the child's blood may still be aerated to some extent through the mother.

In ordinary circumstances little effort is needed to excite breathing beyond the slapping, &c., already noted. All that remains to be done, then, is to tie and cut the cord. This is done in the following way. Two pieces of linen thread, folded twice, each with a large knot at both ends, are used. One piece is tied tightly round the cord, about 2 inches from the belly, and the other piece an inch farther away. The cord is then divided *between the two pieces of thread.* Care must be taken that, in the act of tying, the cord is not suddenly jerked, lest it be torn from its attachment to the belly, which would occasion bleeding very difficult to stop. Further, while the cord is being divided, care must be taken lest the child, by a sudden twist, brings fingers, toes, or other part between the scissors. As soon as the child is separated from the mother its eyes are wiped clean with a fresh piece of gamgee; it is wrapped in a square of flannel ready for the purpose, and laid in a safe, warm place, while attention is again given to the mother.

If the pulsation has stopped, and the child's breathing is not yet established, the cord should be tied, and then divided, and the child's body should be quickly plunged into a basin of warm water, the head, of course, being supported, and then as quickly removed from it, and cold water plentifully dashed over the chest, then plunged again into the hot water and again the cold dashed over it, till by the sudden changes the breathing is established. If these methods do not speedily produce the desired effect, artificial respiration must be resorted to. The little finger (quite clean) of the attendant should be introduced into the mouth and passed to the back of the throat to sweep out any mucus there. Then one of two methods may be adopted. Dr. Howard, of New York, advises that the child be supported on the attendant's left hand and arm (as shown in Fig. 211), while the right hand grasps the lower part of the chest. The chest is steadily compressed for three seconds, and then suddenly let go. After waiting for three seconds the pressure is repeated, and so on, ten to twelve times a minute. The second method consists in the attendant, after cleaning the child's mouth, applying his or her own mouth closely to it, and, the child's nostrils being closed, gently and steadily blowing till the chest is seen to be inflated. On allowing the nostrils to open, the chest will fall again; they should be again closed, and the blowing repeated. This should be continued for a considerable time, at the rate of ten to fifteen times a minute, and if any effort to breathe be made by the child itself the blowing should be timed to aid it.

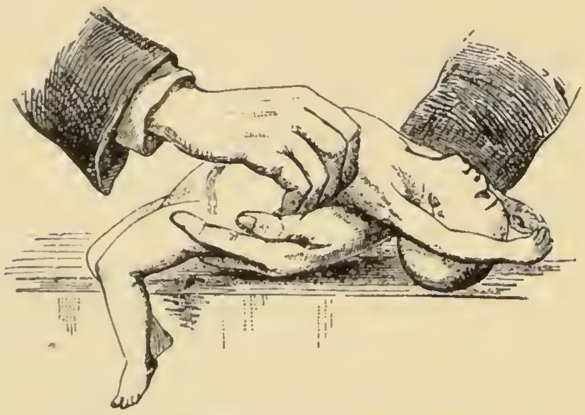


Fig. 211.—Howard's Method of causing Breathing in the Newly-born.

If these measures fail to make the child breathe, the child will often be caused to do so by grasping it with both ankles in the right hand, and gently lifting it so till it hangs head downwards. This manœuvre will produce a gasp. The child is then lowered on to its back and again lifted in the same way, and this movement is repeated till breathing is established. Because the child does not at once breathe, no hasty conclusion that it is still-born should be reached. Prolonged and patient persistence will often be rewarded.

Management of the Third Stage of Labour.—The first thing requiring attention after the removal of the child is the removal of the after-birth. This is the third stage of labour (see p. 638).

If the nurse's hand has been pressing down on the womb from the outside during the birth of the child, this will probably have aided the separation of the after-birth. The hand is to be again applied on the belly over the womb, which ought to be felt as a firm, roundish mass, and if the womb be grasped, and gently but firmly pressed downwards and backwards, a slight rubbing movement being at the same time practised, the womb will usually be found to grow smaller and firmer, and to descend. The hand must follow it, the firm pressure being continued, when the after-birth will be readily expelled. *The after-birth is not to be removed by pulling on the cord*, only a gentle pull is to be exerted on it, if the womb is contracted, and merely to aid its expulsion, not forcibly to draw it out. When it appears at the external opening it is to be taken into the grasp of the hand and twisted round and round a considerable number of times. This coils the membranes, expelled with it, into a sort of rope, and prevents any part of them being retained in the womb, to give rise to severe after-pains. After the removal of the after-birth the patient may roll round on to her back. The nurse's hand, meantime, should be kept pressing on the womb, and if it show signs of relaxing to any extent, by growing larger and rising up into the belly again, slight rubbing and gentle kneading will cause renewed contraction, and in a short time it will remain firmly contracted.

The after-birth usually comes away in from 20 to 30 minutes after the birth of the child, but it may immediately follow the child, or it may be delayed two hours. In ordinary circumstances, therefore, even though a nurse be without help, she may safely leave the mother, as soon as the child is born, to attend to it, if any delay has occurred in its breathing.

On the other hand, if the child breathes and cries lustily, the nurse, having laid it in a safe place, should return at once to the mother, turn her on to her back, and by the hand over the belly assist to keep the womb contracted, and thereby assist to limit the loss of blood till the after-birth is expelled. If this is delayed she should sit down at the bedside, being assured of the safety of the child, and keep her hand over the womb, gently kneading and pressing it, and now and again trying by a gentle strain on the cord to see whether the after-birth be not actually out of the womb, and merely lying in the passage.

So long as the womb feels hard under the hand, and is not becoming soft and again becoming distended, there is no need for hurry. The patient may be directed to cough and to press down, and this may be enough to expel it. After fully half an hour's delay the nurse may gently insinuate the whole hand into the passage, and, finding the placenta there, sweep it wholly out, but it must not be torn. Before doing this, however, the nurse must

> **thoroughly wash and scrub her hand, and soak it in lysol solution, as directed on p. 636.**

If it is not found lying in the passage, the cord must on no account be pulled on. Medical aid must be summoned, and meantime the nurse must sit, maintaining pressure over the womb and the gentle kneading to keep it firmly contracted. If she does not do so, serious bleeding may occur. This is called **post-partum hæmorrhage**, and may be due to irregular contraction of the womb—**hour-glass contraction**—imprisoning the after-birth, or to adhesions between the after-birth and the wall of the womb.

The Treatment of the Mother after the Completion of Labour.—The after-birth having been removed, the petticoat guarding the bed-clothes from staining should be undone, the draw-sheet or accouchment sheet unpinned, and so rolled up under the mother and withdrawn as to enclose all discharge. It is well at this point, if possible, to slip a warm bath-towel under the mother, and with fresh squares of gamgee and fresh lysol solution to sponge thoroughly clean the mother's person, removing all clots and blood-stains. Opportunity must be taken to see to what extent, if any, the parts have been torn, and if any tear is found in the perinæum, medical assistance must be got to stitch it. Meantime the parts are thoroughly cleansed and dried with squares of gamgee, and a perfectly clean bandage or folded napkin is used to tie round both legs and keep them together till the stitching is done. The towel is then removed, the fresh, warm, folded blanket or sheet of absorbent wool or gamgee is spread under the patient, a clean, warm napkin or diaper of gamgee placed close up between the legs and fixed by attachment to the binder.

The binder should be of a breadth suitable to the patient, extending from just below the edge of the haunch-bones to just below the breasts, and sufficiently long to go comfortably once round the patient. It should be fixed, as tightly as is pleasant to the patient, by means of safety-pins. It is customary to place a square pad of gamgee or a folded towel in front, just over the contracted womb.

It is the fashion to decry the value of the pad and binder. There is certainly little value in the pad, but the binder adds greatly to the comfort of the mother, by holding her together, so to speak, if it is properly put on.

The clothing and bed-clothes are now adjusted, and the patient left to rest, the head being low.

Soon after the mother has been made comfortable she may have a warm drink, cup of warm tea or such simple drink, *but no stimulant.* It is well as soon as the child is dressed to put it to the breast, if the mother is not too tired, for a few minutes. The contact of the child's mouth with the breast gently stimulates the contraction of the womb, and tends to prevent relaxation of the womb and bleeding. Regularly every third hour thereafter the child must be replaced at the breast (see p. 560) whether there be milk or not. The effort at sucking promotes the production of milk.

The After-treatment of the Child.—The nurse should now return to the infant. Having brought a child's bath in front of the fire, and placed at hand soap, sponge, towels, dusting-powder, a square of gamgee, a little olive-oil, and the child's clothing, and a low chair or stool to sit on, she proceeds to bathe and clothe the child.

First of all, the child lying on her lap, she should carefully scrutinize it all over, head, ears, eyes, limbs, fingers and toes, back, chest, and abdomen, to note any irregularity of any kind. In the case of a male child she should see if each testicle is down in the pouch of the scrotum, and whether the foreskin can be easily pulled over the point of the penis. Very frequently the opening of the foreskin is a mere pin-point. If this too-small opening be not enlarged by circumcision, or by some other method, trouble will certainly result.

A cross, ill-natured child is quite often the consequence of a narrow foreskin, which retains drops of urine, permitting inflammation to occur between the under surface of the foreskin and the upper surface of the penis.

This, therefore, if present, should be noted for the doctor's attention.

The outlet of the bowel should also be looked to, as in rare cases it is imperfect.

The possibility of rupture (p. 606) must not be overlooked in this scrutiny, and the condition of the cord. If there be any oozing of blood a fresh thread should be tied nearer to the child than the original one. The child is now quickly washed, the eyes being first bathed, then the head, and then the rest of the body.

Especially must the child's limbs be gently stretched from the body to permit the folds of skin to be thoroughly cleansed.

Sometimes parts, or the whole of the body, are covered with a white material which soap and water do not remove. Such parts should be rubbed with the olive-oil, or vaseline, or lard, or butter, till a kind of lather is produced, which washing will then readily remove.

The child must be very carefully dried, and then lightly dusted. Note that careful drying is necessary before dusting. If dusting-powder be laid on damp skin it forms a cake which will rapidly excoriate the infant's tender skin. In no place is the powder to be laid on thickly, else the same thing will happen with the natural moisture of the part.

The stump of the cord must now be dressed. It should be bathed with clean lysol solution, dried with gamgee, and then folded in a fresh piece. In the centre of the square piece of gamgee is made a small slit; through this pass the cord, then fold the gamgee over upon it. It is then lightly secured by the binder. If properly put on, the gamgee may remain undisturbed for a day or two, when it should be replaced by a fresh piece, without pulling on the cord. The stump usually drops off about the fourth or sixth day. The raw surface should be bathed by lysol solution or boric solution, dried with gamgee, and protected by a fresh piece till it is no longer raw. Infection may reach the child by this route, and erysipelas and peritonitis arise if care be not taken

The clothing suitable for the child is given in detail on p. 549, and its food on p 560. It should get no sugar and water, nor anything but the breast milk or bottle food.

It should, immediately after being dressed, be put for a brief period to the mother's breast (see p. 645). The first breast milk of the mother is of a peculiar character, called **colostrum**, which acts upon the child's bowels. The first material from the child's bowels is of a very dark brown colour. It is called **meconium**, and it is not infrequently forced out of the bowel by the pressure on the child at birth.

The child should sleep in its own cot, and never in the same bed with the mother.

The further management of the child is given in detail in the preceding section.

THE LYING-IN PERIOD.

This is the phrase applied to the time following labour till the mother is able to be about again. It is also called the **puerperium**. For the first few hours after labour the mother should continue to lie on her back, and after that time as she pleases.

Sleep is of infinite value. The nurse should lose no time in clearing away all soiled things, tidying the room, and leaving the mother to rest, taking care to be within easy call.

After the mother has had a good rest, a regular routine should be begun.

Diet.—The mother should be fed at absolutely regular hours to a minute. The material should be chiefly liquid, the quantities small, the intervals correspondingly brief. The following will be found a suitable dietary:—

6 a.m.: Cup of tea, with fresh toast and butter or plain bread and butter.
8 a.m.: Tumbler hot milk, bread and butter; or porridge and milk; or bread-and-milk saps.
11 a.m.: A small cup of thin soup, no bread.
1 p.m.: A large cup of soup with finely chopped vegetables, dry toast; or some milk pudding and milk.
4 p.m.: A cup of tea and a biscuit.
7 p.m.: A tumbler of hot milk with bread and butter.
10 p.m.: Gruel.

During the night, but only if desired, a cup of hot milk may be given.

Water may be given in small quantities whenever wished.

A drinking-cup is used, the mother not being permitted to sit up for any purpose.

This diet is quite sufficient for the first four or five days. After the bowels have been moved, but not till then, the mother being well and free from any feverishness, the

1 p.m. meal may consist of a lightly-boiled egg, with milk and bread and butter; or a little steamed fish with bread and butter.
5 p.m. will then be the afternoon tea, and the other meals as before.

After two or three days longer, chicken, cutlet, &c. may be given at 1 p.m., with a potato and a little vegetable.

Attention to the bladder must be given by the nurse from the beginning. Within six or eight hours after labour the bladder should be emptied. If this does not happen, the patient may be allowed to move round to try to empty the bladder, and if this fails, warm cloths should be applied over the front. If medical assistance is obtainable, delay should not be permitted in sending, and if that is not at hand, the nurse should delay as long as possible before she takes the responsibility of doing anything herself.

If, however, because of pain or the time that has elapsed, it becomes necessary to pass a catheter, the nurse cannot take too much care to avoid infection of the bladder. The catheter —the pure rubber by preference—should first be boiled for several minutes (see p. 634). Then, before removing it from the boiling water, the nurse should sterilize her hands, that is render them free of infective material, by the course stated on p. 636. The catheter should then be removed from the boiling water and dropped into a perfectly clean vessel with a solution of carbolic acid (1 to 40), or of lysol (half teaspoonful to a pint). The patient is then turned on her back, and the clothes so arranged as regards the light, that, with the thighs separated, a good view of the parts is obtained and the urinary entrance plainly seen. A perfectly clean towel is then placed under the patient, the parts then carefully cleansed with warm water and soap, and then carefully bathed with lysol solution of the above strength. Then the nurse, holding the lips of the passage apart with one hand, gently passes the catheter into the urinary passage with the other, a slight screwing movement being used. The outer end of the catheter should dip into a vessel perfectly clean. On withdrawing the catheter the nurse should take care to pinch it in order to prevent any urine running from it over the parts, and the parts should be cleansed anew with lysol solution and dried with gamgee.

The catheter should be immediately washed; clean water should be run through it; it should then be boiled and laid aside in a piece of clean gamgee.

Bathing.—The parts of the mother should be repeatedly cleansed each day with antiseptic solution (carbolic, 1 to 20, or lysol, half tea-spoonful to a pint), dried with gamgee, and a fresh piece of gamgee applied as a napkin, the soiled pieces being immediately removed and burned.

But the rest of the body must be regularly sponged also, daily, with soap and warm water. After careful drying, a little spirit of wine may be used to parts subject to pressure.

The draw-sheet needs careful attention, and the bed should always be sweet and free from odour.

The Bowels.—If the advice given as to the movement of the bowels daily, before the labour comes on, is followed, it will be found that the mother remains quite comfortable for even four or five days after delivery, without a movement. But by the third day the bowels may be gently stimulated, and the best means is by castor-oil given in small doses at intervals. Thus a tea-spoonful given every four or six hours, beginning on the third day, is likely to move them without pain or great disturbance within twenty-four hours. If not, an enema of glycerine, or oil and soapy water, may be given. A bed-pan should always be used. A daily movement should be afterwards obtained.

The Breasts.—The child should be put to the breast with absolute regularity every three hours: 6 and 9 a.m.; 12 noon; 3, 6, and 9 p.m. Refer to p. 560.

Before the child is put to the breast the nipple should be carefully sponged and dried. After the child is removed they should also be sponged, dried, and then boric acid and glycerine applied, or, if the skin tends to crack, vaseline.

If they become painful by overdistention, the mother may obtain relief by a draught of fruit salt or Epsom salts, and by the application of a firm binder over them.

Visitors are forbidden for the first week.

Sitting up in bed is not to be allowed till the seventh day, and then only for a brief period for meals, and the patient must not be allowed out of bed at all before the tenth day, and then only for a few minutes, wrapped in blankets. A fortnight after the birth is soon enough to permit the mother to get up for any length of time with clothes on. Even by that time she should rise for say an hour in the forenoon and an hour in the evening, and each day gradually lengthen the time till after another week she spends the better portion of the afternoon out of bed. It is infinitely better for her to take a long period of rest in order to rise thoroughly recovered and with restored strength, than to get up too soon and require to take soon to bed again with full recovery impeded. Details as to the management of the period of nursing are given on pp. 560 to 563.

After-pains are of the nature of labour pains on a small scale, and are due to irregular contractions of the womb, owing to the presence of blood clots and the effort to expel them. As a rule they do not occur after a first labour, and may be greatly lessened after subsequent labours by the method of following the descent of the womb with the hand, and by the method of removing the after-birth, which have been described. They may be relieved by the application, close up between the legs, of a thick pad of flannel wrung tightly out of hot water. If they are severe a single dose of ten drops of laudanum may be given. This is to be repeated in two or three hours, only if really necessary.

The Discharge from the womb for the first twenty-four hours after labour is of blood, and contains sometimes small clots. It gradually becomes less red, and by the third or fifth day assumes a greenish or yellowish hue. It has a peculiar odour. It gradually becomes colourless, and finally ceases by the end of two or three weeks. For the first few days the discharge is to be promoted by occasional gentle bathing of the external parts with warm water. Strict cleanliness must be observed, and clean napkins freely employed.

THE PRACTICE OF MIDWIFERY BY MIDWIVES.

Owing to the high mortality of women in child-birth, the British Parliament, in 1902, passed "The Midwives Act" appointing a central board, "The Central Midwives Board", to regulate the practice of midwifery by midwives. This board is the governing authority for all midwives in England and Wales.

This board regulates the training of midwives, and frames rules for their supervision and registration.

According to the Act, every woman practising as a midwife must be certified and entered on the Roll of Midwives.

For each district of England and Wales a Local Supervising Authority is appointed to carry out the regulations.

The Local Supervising Authorities are the County and County Borough Councils, and they are empowered, if they see fit, to delegate their duties to committees, or to the district councils.

Such Local Authorities are to exercise supervision over all midwives practising within the area of the county or county borough, and to investigate charges of malpractice, negligence, or misconduct.

The following extracts from the Rules framed by the Central Midwives Board, under Section 3 (1) of the Act, are those which every midwife should take careful note of.

B.—REGULATING THE ISSUE OF CERTIFICATES AND THE CONDITIONS OF ADMISSION TO THE ROLL OF MIDWIVES.

1. Candidates must satisfy the Central Midwives Board that they have reached a sufficient standard of general education, and submit the following documents, duly filled in and signed:—

(*a*) A certificate of birth, showing that the candidate is not under twenty-one years of age;

(*b*) Certificates to the effect that the candidate has undergone the training set forth in *C* 1 (1) (2) and (3);

(*c*) A certificate of good moral character. This certificate must be in the form prescribed by the Central Midwives Board. The person signing must state in the certificate that he or she has known the candidate for at least twelve months, and must append to his or her signature a statement of his or her calling or position.

2. Candidates must pass an examination as hereinafter set forth. (See *C* below.)

3. A candidate who has complied with the above requirements and has successfully passed the examination shall receive a certificate in the form set out in the Schedule, and her name shall be entered by the secretary on the Roll of Midwives.

C.—REGULATING THE COURSE OF TRAINING AND THE CONDUCT OF EXAMINATIONS.

1. No person shall be admitted to an examination unless she produces certificates that she has undergone the following course of training, viz.:—

(1) She must have, under supervision satisfactory to the Central Midwives Board, attended and watched the progress of not fewer than twenty labours, making abdominal and vaginal examinations dur-

ing the course of labour and personally delivering the patient.

(2) She must have, to the satisfaction of the person certifying, nursed twenty lying-in women during the ten days following labour.

The certificates as to (1) and (2) must be in the form prescribed by the Central Midwives Board, and must be filled up and signed either by a registered medical practitioner or by the Chief Midwife, or, in the absence of such an officer, by the matron of an institution recognized by the board, or, in the case of a poor law institution, by the matron, being a midwife certified under the Midwives Act, or a superintendent nurse, certified in like manner and appointed under the Nursing in Workhouses Order, 1897, and attached to such an institution, or by a midwife certified under the Midwives Act and approved by the board for the purpose.

(3) She must have attended a sufficient course of instruction in the subjects named below. (See Clause 4 below.)

No period of less than three months shall be deemed sufficient for the purpose.

The above certificate (3) must be in the form prescribed by the Central Midwives Board, and must be filled up and signed by a registered medical practitioner recognized by the board as a teacher.

2. Candidates who intend to present themselves for examination must send notice to the secretary of the Central Midwives Board at least three weeks before the date fixed for the examination to commence, accompanied by the certificates mentioned in *B* 1 and *C* 1, and by the payment of the fee of one guinea, or, in the event of the candidate having presented herself on a former occasion and having failed to pass, the fee of fifteen shillings.

3. Any candidate who during the examination shows a want of acquaintance with the ordinary subjects of elementary education may be rejected on that ground alone.

4. The examination shall be partly oral and practical, and partly written, and shall embrace the following subjects:—

(*a*) The elementary anatomy of the female pelvis and generative organs.

(*b*) Pregnancy and its principal complications, including abortion.

(*c*) The symptoms, mechanism, course and management of natural labour.

(*d*) The signs that a labour is abnormal.

(*e*) Hæmorrhage: its varieties and the treatment of each.

(*f*) Antiseptics in midwifery and the way to prepare and use them.

(*g*) The management of the puerperal patient, including the use of the clinical thermometer and of the catheter.

(*h*) The management (including the feeding) of infants, and the signs of the important diseases which may develop during the first ten days.

(*i*) The duties of the midwife as described in the regulations.

(*j*) Obstetric emergencies, and how the midwife should deal with them until the arrival of a doctor. This will include some knowledge of the drugs commonly needed in such cases, and of the mode of their administration. (See *E* 16.)

(*k*) Puerperal fever, its nature, causes and symptoms. The elements of house sanitation. The disinfection of person, clothing, and appliances.

E.—REGULATING, SUPERVISING, AND RESTRICTING WITHIN DUE LIMITS THE PRACTICE OF MIDWIVES.

Directions to Midwives.

1. The midwife must be scrupulously clean in every way, because the smallest particle of decomposing matter may set up puerperal fever.

She must wear a dress of washable material, and over it a clean washable apron.

Note.—It is best to have the sleeves of the dress made so that the midwife can tuck them well up above the elbows.

A midwife who is attending a case in which there are foul-smelling discharges must not go direct to another case without first changing her dress and thoroughly cleansing and disinfecting her hands and forearms and such appliances (2 (*a*) below) as she may have had occasion to use, and is obliged to take with her.

Note.—Unless the cleansing process be thoroughly carried out there will be, even after a healthy confinement, remains of blood, lochia, or liquor amnii on the fingers, and especially under the nails, which will there undergo decomposition, and so become dangerous to the next patient attended. The midwife must, therefore, keep her nails cut short, and preserve the skin of her hands as far as possible from chaps and other injuries.

2. When called to a confinement a midwife must take with her:—

(*a*) An appliance for giving vaginal injections, an appliance for giving enemata, a catheter, a pair of scissors, a clinical thermometer, and a nail-brush.

(*b*) An efficient antiseptic for disinfecting the hands, &c.

(*c*) An antiseptic for douching in special cases.

(*d*) An antiseptic lubricant for smearing the fingers, catheters, douche nozzles, and enema nozzles before they touch the patient.

3. On each occasion of touching the genital organs or their neighbourhood the midwife must previously disinfect her hands and forearms.

4. All instruments and other appliances brought into contact with the patient's generative organs must be properly disinfected.

5. Whenever a midwife has been in attendance upon a patient suffering from puerperal fever, or from any other illness supposed to be infectious, she must disinfect herself and all her instruments and other appliances, to the satisfaction of the local sanitary authority, and must have her clothing thoroughly disinfected before going to another labour. Unless otherwise directed by the local supervising authority, all washable clothing should be boiled, and other clothing should be sent to be stoved (by the local sanitary authority), and then exposed freely to the open air for several days.

DUTIES TO PATIENT.

6. If a midwife has charge of a lying-in case she must not leave the patient after the commencement of the Second Stage, and she must stay with the woman until the expulsion of the after-birth, and as long after as may be necessary. In cases where a doctor has been sent for on account of the labour being abnormal, or of there being threatened danger, she must await his arrival and faithfully carry out his instructions. (See Clauses 12 and 17 below.)

7. Before making the first internal examination, and always before passing a catheter, the midwife must wash the patient's external parts with soap and water, and then swab them with an antiseptic solution. For this purpose, and for washing the external parts immediately after labour and during the lying-in, on no account must ordinary sponges or flannels be used, but material which can be boiled before use and thrown away afterwards, such as linen, cotton-wool, cotton-waste, tow, &c.

8. No more internal examinations should be made than are absolutely necessary.

9. On the birth of a child which is in danger of death, the midwife shall inform one of the parents of the child's condition.

10. The midwife must remove soiled linen, blood, fæces, urine, and the placenta from the neighbourhood of the patient and from the lying-in room as soon as possible after the labour, and in every case before she leaves the patient's house.

11. The midwife shall be responsible for the cleanliness, and should give full directions for securing the comfort and proper dieting, of the mother and child during the lying-in period, which shall be held, for the purpose of these regulations and in a normal case, to mean the time occupied by the labour and a period of ten days thereafter. (See Clause 17 (*c*).)

12. A "case of normal labour" in these regulations shall mean a labour in which there are none of the conditions specified in Clause 17 below.

DUTIES TO CHILD.

13. In the case of a child being born apparently dead, the midwife should carry out the methods of resuscitation which have been taught her.

14. As soon as the child's head is born, and if possible before the eyes are opened, its eyelids should be carefully cleansed with a suitable antiseptic lotion.

GENERAL.

15. No midwife shall undertake the duty of laying out the dead, or follow any occupation that is in its nature liable to be a source of infection.

16. A midwife must enter in a book, with other notes of the case, all occasions on which she is under the necessity of administering any drug—whether scheduled as a poison or not,—the dose, and the time and cause of its administration.

17. In all cases of abortion, of illness of the patient or child, or of any abnormality occurring during pregnancy, labour, or lying-in, a midwife must decline to attend alone, and must advise that a registered medical practitioner be

sent for, as, for example, under the following circumstances:—

(*a*) In the case of a pregnant woman:

(1) When she suspects a deformed pelvis;

(2) When there is loss of blood;

(3) When the pregnancy presents any other unusual feature (as, for example, excessive sickness, persistent headache, dimness of vision, puffiness of face and hands, difficulty in emptying the bladder, incontinence of urine, large varicose veins, rupture), or when it is complicated by fever or any other serious condition.

(*b*) In the case of a woman in labour:

(1) In all presentations other than the uncomplicated vertex or breech; in all cases of breech presentation in primiparæ; in all cases of flooding and convulsions; and also whenever there appears to be insufficient room for the child to pass, or when a tumour is felt in any part of the mother's passages.

(2) If the midwife, when the cervix has become dilated, is unable to make out the presentation.

(3) If there is loss of blood in excess of what is natural, at whatever time of the labour it may occur.

(4) If an hour after the birth of the child the placenta has not been expelled, and cannot be expressed (*i.e.* pressed out), even if no bleeding has occurred.

(5) In cases of rupture of the perinæum, or other serious injury of the soft parts.

(*c*) In the case of lying-in women, and in the case of newly-born children:

Whenever, after delivery, the progress of the woman or child is not satisfactory, but in all events upon the occurrence of the subjoined conditions in—

(I.) *The Mother:*

(1) Abdominal swelling and signs of insufficient contraction of the uterus.

(2) Foul-smelling discharges.

(3) Secondary post-partum hæmorrhage.

(4) Rigor.

(5) Rise of temperature above 100° 4′ F. with quickening of the pulse for more than 24 hours.

(6) Unusual swelling of the breasts with local tenderness or pain.

(II.) *The Child:*

(1) Injuries received during birth.

(2) Obvious malformations or deformities, not inconsistent with continued existence.

(3) Concealed malformations—Incapacity to suck or take nourishment.

(4) Inflammation, to even the slightest degree, of the eyes, eyelids, and ears.

(5) Syphilitic appearance of the skin in certain parts.

(6) Illness or feebleness arising from prematurity.

(7) Malignant jaundice (icterus neonatorum).

(8) Inflammation about the umbilicus (septic infection of the cord).

(*d*) In all cases of the death of a woman during pregnancy, labour, or lying-in.

When a registered medical practitioner is sent for, the midwife must state in writing the condition of the patient and the reason of the necessity for medical advice, in accordance with Clause 19 (*b*).

18. Notification.

(1) *Deaths.*—In all cases in which the death of the mother or of the child occurs before the attendance of a registered medical practitioner the midwife shall, as soon as possible after the death, notify the same to the local supervising authority.

(2) *Still-births.*—In all cases where a registered medical practitioner is not in attendance the midwife shall, as soon as possible after the occurrence of a still-birth, notify the same to the local supervising authority.

A child is deemed to be still-born when it has not breathed or shown any sign of life after being completely born.

(3) *Puerperal Fever and other Infectious Diseases.*—These cases are included in the notice required when medical help is sent for. (See 19 (*b*) below.)

19. A midwife shall keep the following records:—

(*a*) A register of cases, in the following form:—

No. ....

Date of engagement to attend ....

Name and address ....

....

No. of previous labours and miscarriages.................

Age...

Date and hour of Midwife's arrival.........................

Presentation ....

Duration of 1st, 2nd, 3rd stage of labour.................

Complications (if any) during or after labour ....

....

Sex of infant...................Born living or dead........

Full time or premature—No. of months ....

If Doctor called .... Name of Doctor.............

Date of Midwife's last visit.................................

Condition of Mother then (See clause 11 above.)........

....

Condition of Child then.......................................

Remarks[1] ....

....

....

....

(*b*) A record of sending for medical help, in the following form:—

No. ....Date.....................................

Name of Patient ....

Address...

requiros medical assistance at once on account of.....

....

Signed................................(Certified Midwife)

Sent to (doctor)...

at (address)..

Time of sending message....................................

The midwife shall make two copies of the above (*b*) by means of transfer paper or otherwise; she shall preserve one of these copies for herself, and shall send the other by post to the local supervising authority within twelve hours. (See Clause 18 (3), above.)

The Midwife is also recommended to keep a Case Book with fuller details.

20. The supervising authority shall make arrangements to secure a proper inspection of every midwife's case book, bag of appliances, &c., and, when thought necessary, an inspection of her place of residence, and an investigation of her mode of practice.

21. Nothing in this section (*E*) shall apply to certified midwives exercising their calling in Hospitals, Workhouses, or Poor Law Infirmaries under the supervision of a duly-appointed medical officer.

F.—DECIDING THE CONDITIONS UNDER WHICH MIDWIVES MAY BE SUSPENDED FROM PRACTICE.

In carrying out Section 8 (3) of the Midwives Act it shall be the duty of the local supervising authority to suspend a midwife from practice who contravenes the directions for the use of disinfectants and for the employment of proper safeguards against the spread of infection, and any other rules for the purpose laid down by the Central Midwives Board, and in the exercise of that duty the local supervising authority shall, after communicating their decision in writing to the midwife concerned, at once report any suspension (with the grounds thereof) to the Central Midwives Board.

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[1] If any drugs have been administered state here their nature and dose, and the time and purpose of their administration.

SECTION XXIX.

THE DISEASES OF WOMEN.

Affections of the Generative Organs:
- *Diseases of the External Parts*—Eruptions—Sensitive Red Patches—Itching of the Genitals—Inflammation—Boils and Abscess;
- *Diseases of the Vaginal Passage*—Inflammation—Discharges (*Leucorrhœa—Whites*)—Fistula—Tumours and Growths (Cancer, &c.);
- *Diseases of the Womb*—Inflammation, Ulceration, and Tumours (Polypus, Fibroid, and Cancer)—Displacements and Falling (*Prolapse*) of the Womb;
- *Diseases of the Ovaries*—Inflammation, Neuralgia, and Tumours.

Disorders of the Monthly Illness (Menstruation):
- *Absence of the Monthly Illness (Amenorrhœa);*
- *Irregularity or Scantiness of the Monthly Illness;*
- *Excessive Monthly Illness (Menorrhagia and Metrorrhagia);*
- *Painful Monthly Illness (Dysmenorrhœa);*

Affections of the Bladder, &c., in Women:
- *Painful, Difficult, and Frequent Passing of Water.*

Nervous Diseases of Women:
- *Hysteria, Catalepsy, Trance, and Ecstasy.*

Diseases of Pregnancy:
- *Derangements of Stomach and Digestion*—Excessive vomiting, &c.;
- *Disturbances of Breathing;*
- *Disturbances due to Pressure*—Dropsy, Varicose Veins and Piles;
- *Nervous affections;*
- *Miscarriage and Flooding;*
- *Molar Pregnancy or Blighted Mole.*

Difficulties during Labour:
- *Protracted Labour;*
- *Delay during the First Stage;*
- *Delay during the Second Stage;*
- *Cross-Birth;*
- *Contracted Pelvis of the Mother*—Flat Pelvis.

Diseases after Child-birth:
- *Flooding;*
- *Affections of the Breasts*—Gathered Breast;
- *Defective and Excessive Supply of Milk;*
- *To Stop the Production of Milk;*
- *Irregularities of the Discharge and Bladder Troubles;*
- *Fever after Child-Birth*—Milk-Fever—Puerperal or Child-bed Fever;
- *Nervous Affections after Child-Birth*—Convulsions and Insanity.

Sterility.

AFFECTIONS OF THE EXTERNAL GENERATIVE ORGANS.

ERUPTIONS AND ITCHING.

The skin in the neighbourhood of the external opening of the genital canal is liable to many of the affections common to the skin in other parts, and such affections may affect the membrane lining the entrance to the passage.

Thrush, for example, such as occurs in white patches in the mouths of children, is not infrequent. Refer to p. 599. The treatment described there is to be adopted.

Herpes (p. 424) is also found. It soon disappears if kept smeared with vaseline or zinc ointment, and if cleanliness be exercised.

Inflammatory Blush (p. 419), due to irritating discharges or the rubbing of opposed surface, is to be treated by bathing with warm water, then drying carefully, and dusting with oxide of zinc powder.

Erysipelas is to be treated as advised on p. 420.

Eczema (p. 425) is usually due to irritating discharges, to dribbling of urine, and is frequently the result of diabetes (p. 407). It occurs in very fat women, who perspire freely and are not sufficiently given to frequent bathing. It may spread from the inner surface of the passage outwards over the skin, down the thighs, and up over the belly, and round to the opening of the bowel. The surface is red and leaking, crusts form owing to the drying of the discharges, and bleeding cracks are produced. The parts are extremely sore and smarting, and painfully itching. The intolerable itching causes frequent scratching, which tears the tender surface, causing it to bleed. The main part of the treatment is scrupulous cleanliness. The parts should be bathed several times a day with warm water, and some mild soap—glycerine or tar soap. Any discharge from the passage, or any other apparent cause, must, of course, be got rid of. Bathing with warm lime-water or warm water to which a pinch of carbonate of (baking) soda is added, relieves the itching. An ointment may then be used made of oleate of zinc (60 grains) and vaseline (2 ounces), or oleate of bismuth (60 grains) and vaseline (1 ounce), or chrisma sulphur. In the absence of these the ordinary oxide of zinc ointment, made with vaseline instead of lard, will do; or a wash made of glycerine (1 ounce), borax (60 grains), and rose-water (1 ounce). Should such measures fail, the person must consult a doctor, lest diabetes be at the root of the trouble, or some irritating condition of the urine.

Warts, of a soft kind usually, are found just at the opening of the passage or just within. Sometimes they exist in great numbers. They may be removed by the use of glacial acetic acid, very carefully applied. The top of the wart alone is touched, and the application is repeated daily till it disappears. The patient herself should not attempt to apply it, as she will certainly be unable to prevent the acid running on to sound skin. Besides this, the part should be frequently bathed, dried, and dusted. Any discharge should be treated.

Tubercles, growths much larger than warts, also occur. They require skilled treatment.

Sensitive Red Patches are occasionally found just within the entrance of the passage. They may be associated with small, red, sensitive growths round the opening of the urinary passage. They occur about the time of the change of life; they occasion much distress, and are very difficult of treatment. It is almost useless to mention treatment here, but any irritating discharge should be removed, if possible, and strict cleanliness should be observed. Some dry cotton-wool inserted just within the passage will make walking more easy, and at bed-time a plug of wool, soaked in a solution made of equal parts of glycerine and neutral acetate of lead, will relieve pain. Any of the sensitive growths referred to require the aid of a surgeon for their removal.

Itching of the Genitals (*Pruritus*).—This is often a most distressing complaint. The itching is intense, accompanied by burning heat and tingling. It is commonest in women advanced in life, though it also occurs in the young. The itching is usually aggravated by warmth, and thus the suffering is most intense shortly after the person gets warm in bed.

It is not necessarily accompanied by an eruption, though it is the companion and effect of such a disease as eczema, referred to on the preceding page; but it may exist, to begin with, without any eruption or any appearance of change in the skin whatever. But as a result of the scratching, from which the patient cannot refrain, though it is painful, cracks, scratches, &c., are produced, which bleed, and with the continual scratching may become themselves painful, and lead to the formation of scabs, crusts, &c. This, however, is not the cause but the result of the itching, in this particular instance.

Treatment.—Such itching as has been described is not to be regarded as a disease in itself. It is to be looked on rather as a sign of disease, and its true cause must be searched for and found, if it is to be satisfactorily treated.

A common cause is diabetes (p. 407). The writer has seen several cases of this most annoying itching in elderly women, for which no washes or local applications afforded more than a temporary relief, and which had existed more or less for months, and in one case a couple of years, the cause of which showed itself at once on an examination of the urine, and which disappeared very soon after diabetic treatment (p. 408) was resorted to.

The presence of a constant irritation is another frequent cause. The irritation may, however, be of many varied kinds. It may arise from a discharge of whites or other discharge from the womb or genital passage, or the watery discharge of cancer; it may be due to some condition of the urine, excessive acidity, the presence of oxalates (p. 407), stone in the bladder, or worms in the bowel, or, and this is not to be overlooked, it may be the result of the work of the particular kind of louse found in this region (p. 433).

A variety of other conditions may occasion it—a gouty or rheumatic state of body, various unhealthy states of the womb, &c. &c. Besides all these, it would appear sometimes to be due simply to a condition of over-sensitiveness of nerves of the part.

Each cause has its own appropriate method of treatment, and it will usually require the skill and patience of an educated medical man to determine what that cause is, and what the proper treatment ought to be. Without such advice, the patient should try the effect of frequent bathing, and syringing with tepid water, to which a pinch of common baking soda may be added, the parts being dried after the bathing, and then lightly dusted with white oxide of zinc powder. A lotion made of 60 grains of the acetate of lead to 2 ounces of water is very soothing, or a lotion of 1 grain of bichloride of mercury to 1 ounce of water may be tried. The latter is very poisonous, and the bottle containing it should be carefully labelled and kept out of the way, lest accidents happen from mistaking it for something else.

Inflammation round the external opening is called **Vulvitis.** It is not seldom met with in infants and young children. Want of cleanliness may be the cause, or injury, and it is not necessary to suspect contagion from the child being ill treated, though, of course, such might be the cause. The parts are red, swollen, painful, itching, and from them flows a mattery discharge. If there is much pain and redness, soothing poultices should be applied, warm bread poultices or warm poultices of boiled mashed turnips. If the parts are not acutely inflamed bathe first with lukewarm water, and then with a lotion made of 20 grains of sulphate of zinc to 10 ounces of water. A gentle purgative of calcined magnesia or effervescing citrated magnesia is useful, and good nourishing food must be given.

Boils and Abscesses form in this region. Soothing poultices must be applied, and any matter present must be removed. This requires a surgeon. Proper advice is all the more necessary, as a rupture (**hernia**, p. 267) occurs here in female children, and must not be mistaken for an abscess.

DISEASES OF THE VAGINAL PASSAGE.

Inflammation extending, that is, beyond the mere entrance, up into the canal, is called properly **Vaginitis.**

Its **cause** may be very various—want of cleanliness, irritation of worms which have passed up the canal from the bowel, the presence of foreign bodies, such as a pessary introduced for a displaced womb, &c. Simple exposure to cold, especially at a monthly period, seems capable of producing it. It occurs, also, in the course of diseases like measles, small-pox, scarlet fever, and is more apt to be found in persons of depressed general health. Irritating injections may be its cause, and it may be the consequence of direct infection.

Symptoms.—The passage is hot and tender, there is a sense of burning and smarting, bearing-down pain, frequent desire to make water, and pain in passing it; aching and throbbing are felt in the passage, and walking is attended with difficulty. The external parts may also be swollen and inflamed. There is also discharge, at first of clear and then of yellowish matter, which is often badly smelling. After a sharp attack the inflammation may pass off in a few days or weeks, or it may become chronic in persons whose vital powers are depressed.

Treatment.—In the period of acute inflammation the person should be kept at rest in bed; brisk saline purgatives, seidlitz-powders, or effervescing citrate of magnesia, should be given, and mild food, milk, soups, &c. *Stimulants must not be given.* Without skilled advice hot hip-baths may be given, or injections or douches of water as warm as can be comfortably borne. The injection should be given with an enema syringe or douche. (See Plate XXXII.) The nozzle should be of caoutchouc, or, still better, of glass, 5 or 6 inches long, and several openings should exist *round the extremity of the nozzle, not one at the very point.* The person should lie on her back, with the hips raised. The water should be injected *slowly*, and care must be taken that it escapes quite easily. From a half to one gallon of water may be used at one time, and the injection may be repeated twice or thrice daily in sharp attacks. After the injection a medicated pessary of 3 grains extract of belladonna should be pushed up into the passage and allowed to remain. It gives great relief. When the acute stage is past an injection of 30 grains sulphate of zinc to 1 pint of water is to be used. At the same time any bad state of general health requires treatment if the disease is to be got rid of.

Discharges from the Passage (*Whites, Leucorrhœa*).—The lining membrane of the passage is studded with minute glands, which produce a clear thickish fluid for keeping the parts moist. Under a variety of circumstances it is so increased in amount as to appear externally as a discharge. Just as when one has cold-in-the-head, or catarrh as it is properly called, the minute glands studding the lining membrane of the nostrils pour out their discharge, which ordinarily is simply sufficient to keep the nostrils moist, and there is in consequence a "running at the nose," so, as the result of exposure to cold or damp, the genital passage may be affected with catarrh and the discharge appear. It may be thin and milky in appearance, or thick and sticky, or yellowish, Commonly it is whitish, and has, therefore, been called "the whites." Besides being the result of cold, it may occur as a symptom of depressed health, in pale delicate girls for example, as an expression of defective nourishment. It may also be a consequence of prolonged nursing. The discharge may originate, not in the passage, but in the womb itself, and may be the expression of some disorder there. In pale, weakly girls such a clear discharge may occur at the monthly periods without any discharge of blood. It will be the constant attendant of chronic inflammatory conditions of the passage.

The subject of such a chronic discharge usually complains of backache, discomfort in the lower part of the belly, and general weakness. This weakness may itself be the cause of the discharge, but the occurrence of the discharge will make the weak state of health all the worse.

Treatment ought to be directed to the cause of the disorder. In states of bad general health efforts must be made to improve the general health. For such a purpose the bowels must be regulated, preferably by such a gentle medicine as a mineral water, for example, a wine-glassful of Hunyadi Janos each morning. A moderate amount of exercise should be obtained daily. Overwork of every kind is most injurious, whether in the case of the married woman who has a house and children to look after, or in that of the girl who has some business occupation in the workshop, warehouse, office, or school, or in the case of the girl going in for the higher education. Easily digested, nourishing food is essential. Change of air and sea-bathing are very valuable, and quinine and iron tonics ought to be administered. In the way of direct treatment to the parts the person should restrict herself, failing advice, to simple measures. Warm-water injections, and injections of a lotion of sulphate of zinc (2 grains of sulphate of zinc to 1 ounce of water), are useful, or injections of iron-alum of the same strength. If the discharge be irritating, an injection of a lotion containing ½ ounce of carbonate of soda (baking soda) to 1 pint of water affords great relief. If such measures fail, competent advice must be obtained. Indeed, where at all possible, such advice ought to be obtained from the commencement, as the inflammation may extend up into the womb and onwards to the ovaries, or to the bladder, and lead to very serious consequences.

Fistula implies the existence of some unusual communication between the genital passage and the lower end of the bowel on one side, or between the genital passage and the urinary bladder on the other. The former is called **recto-vaginal fistula**, and the latter **vesico-vaginal fistula.** The commonest cause of both arises in the course of labour. It may be that the rent occurs in the process of delivery either with or without instruments, from the narrowness of the passage and the want of stretching capacity, or from the size of the child. In such cases it is commonly the partition between the genital canal and the bowel that gives way. It may result from long-delayed labour, when the head of the child becomes fixed, and long-continued pressure is maintained upon some part of the walls. In such a case it is usually the division between the passage and the bladder that yields. Part of the wall has become so damaged by the pressure that, some time after delivery, a day or two or a week or two, it separates and comes away as a slough, leaving an opening, through which the urine from the bladder finds its way into the passage. While the former misfortune may occur even with the most careful and skilled management, the latter is commonly the result of mismanagement, undue delay having been allowed to occur in the use of instruments or other means of hastening delivery. The same unusual communications may be opened up by the bursting of abscesses, by prolonged ulceration, by destruction of parts owing to cancerous disease, by wounds, and so on. But these are less frequent causes than those above mentioned. In the case of the opening between the bowel and passage, matters from the bowel will be passed by the genital opening, and in the case of communication with the bladder, urine will dribble away in an unusual manner. Other results follow. The presence of discharges in the genital passage foreign to it almost certainly occasions some degree of inflammation, extending to the external parts, which become inflamed and ulcerated, and occasion much misery by their constant smarting and itching.

Treatment of such conditions has become much more hopeful in recent years, due mainly to the skill of American surgeons, Emmet and Marion Sims. The treatment consists in an operation for reuniting the edges of the tear. It is, of course, in cases where the rent is comparatively simple, as in those arising during child-birth, that the treatment is likely to be adopted, and not in fistulæ the result of cancerous ulceration.

Tumours and Growths of various kinds may occur in connection with the external parts of the genital organs or in connection with the genital passage.

Abscess may form on one side of the external opening large enough to block the opening, and may appear to the unskilled as a solid growth instead of a mere collection of matter. Such might occur as a result of inflammation, or from some slight blow or bruise, or even from such a slight cause as the tearing out of a hair.

Rupture may occur in a similar situation, though it is rare, forming a swelling due to a loop of bowel passing down from the abdomen into a position similar to that which it occupies in the male (see p. 267). To mistake this for an abscess would be very serious indeed. It can be reduced and prevented from returning by the use of a properly fitting truss.

Cancer occasionally occurs on the external parts, in the form of skin cancer (see p. 556). Within the passage itself cancer does not often occur, unless it extend inwards from the outside, or downwards from the womb. When it is present, pain, bleeding, and a foul discharge are among its usual signs, but nothing is conclusive apart from the opinion of a competent medical man, who has made a thorough examination.

All sorts of **foreign bodies** have been found in the passage, which have been passed in accidentally or by design. It is not uncommon for a doctor to have to remove a pessary, inserted for treatment of displaced womb, which has remained there for years, forgotten by the patient, and has become almost fixed in the parts, in the end producing inflammation, discharge, &c. The removal of such bodies should be attempted only by skilled hands.

DISEASES OF THE WOMB.

INFLAMMATION OF THE WOMB.

This is a very wide term, embracing a variety of diseases known to medical men under special names, and requiring special treatment. It will be sufficient here to indicate the general features which the various forms of the disease have pretty much in common, and the general lines of treatment which can be safely adopted when medical aid is not readily obtainable. If reference be made to p. 619, the distinction will be understood between the body of the womb and the neck of the womb, which latter ends at the mouth, opening into the genital passage. Inflammation, then, may attack both the body and neck of the womb, or it may limit itself to one or other. Further, the womb is largely composed of muscle, but, within, it is lined with a mucous membrane, containing glands buried in it and opening on the surface (inner). The inflammation may exist mainly in the muscular walls, or it may be limited to the inner lining membrane. Thus there may be inflammation of the muscular walls of the *body* of the womb, or inflammation of the lining membrane of the *body* of the womb, and there may be inflammation of the muscular walls of the *neck* of the womb, or inflammation of the lining membrane of the *neck* of the womb.

Here are, then, four varieties of inflammation. Moreover, in each of these four cases the inflammation may be acute or chronic, and so there may be eight forms of inflammation of the womb. The symptoms, while presenting similar general features, will vary somewhat with each separate condition, and the treatment, to be thorough, ought also to vary somewhat to suit the particular case. The extreme advisability, therefore, of anyone suffering from any of the symptoms of disorder of the womb, consulting a skilled medical man, ought to be sufficiently plain.

Happily the inflammation of the muscular walls, whether of body or neck of the womb, may be dismissed with the remark that it is comparatively rare.

Inflammation of the Lining Membrane of the Neck of the Womb.—The common form of uterine inflammation, and it is, in its chronic form, extremely common, is inflammation of the lining membrane *of the neck* of the womb, and to that attention shall be confined, note being taken, in the course of its description, of any symptom indicating that the inflammation has spread upwards to the lining membrane *of the body* of the womb.

Symptoms.—The common symptoms of inflammation of the lining membrane of the neck of the womb, when not of an acute form, are profuse discharge of whites, some amount of pain in the small of the back, worse with standing or walking and increased at the monthly periods, and a sense of indifferent general health. If the disorder has lasted for a considerable time the patient will of necessity suffer from general debility to a greater or less extent, and will be paler than is consistent with health. Her digestion is almost certainly disturbed, and she may suffer from depression or nervousness, and a variety of pains and aches, now in one part of the body and now in another. The bowels are probably confined, and the urine is dark and thick. The discharge that appears externally may be glairy and clear, like white of egg before being boiled, or may be white or yellowish matter.

If the attack be acute there are pain and tenderness in the parts, throbbing with a feeling of bearing down, irritation of the bladder and frequent desire to pass water, and the discharge is often tinged with blood and of an offensive smell.

It is to be noted, however, that inflammation may exist for some time without pain, or any other symptom, except that of a profuse discharge of "whites."

Causes of the disease are numerous. Exposure to damp and cold, especially in those of feeble health, insufficiently nourished, and who fail to obtain sufficient exercise and fresh air, the irritation of a displaced womb, or instruments introduced into the passage to restore a displaced womb to its proper condition, the frequent use of irritating injections, and various other causes may produce it. It is excessively common in married women who have borne children, and too prolonged nursing may with them excite its occurrence. Nor must excessive intercourse and direct infection be omitted in the list of causes.

The condition of the parts is very much that of an inflamed and swollen throat. The lining membrane is swollen and congested, and the discharge proceeds from the glands which exist in it in enormous numbers, just as from a swollen and inflamed throat there proceeds excessive "defluxion."

The Inflammation of the Lining Membrane of the Body of the Womb is attended by discharge similar to the other, but in greater amount, and disturbances of the monthly illness—irregularity, excess, or diminution—are more common. Marked nervous symptoms are often produced by it. The person is fretful and despondent, may suffer from frequent headache, limited to the top of the head, and from other pains, resembling neuralgia, and the dragging pain in the back is very marked. But any difference in symptoms is rather one of degree than of kind.

A not uncommon cause of this condition is sudden stoppage of the monthly flow from cold and the irritation of matters retained in the womb after confinement or miscarriage.

General Treatment of Uterine Inflammation.—It is unnecessary to give a detailed account of the treatment necessary for each variety of these uterine affections. The general line of treatment for all will be pretty fully stated. What has been said about the causes of these affections is sufficient to show that there can be no rough-and-ready or "rule-of-thumb" procedure in dealing with it. If the condition be mainly caused by a bad state of general health, it cannot be supposed that applications to the affected parts will cure it while the general bad health remains. Even though such a cause has not been at work in its production, the disease cannot have lasted any time without inducing some degree of bad health, which will stand in the way of a cure. Then if a displacement of the womb is the cause of the inflammatory process, nothing short of restoring the organ to its proper position can be expected to promote a permanent recovery. A mother who suckles her child beyond the necessary period, and suffers from some disorder of the womb, cannot expect to cure by injections what is maintained by the drain upon her system of prolonged nursing. So with other causes. Now, it would be the business of a medical man, well acquainted with such conditions, to determine the cause at work in each particular case, and to apply his treatment accordingly. It is plain, therefore, that it is really quite impossible to state any definite plan of treatment which a patient might herself adopt with good prospect of recovery from her trouble. The best advice that could be given would be to place herself under the care of a physician from whom she might confidently hope to receive skilful and conscientious treatment. At the same time it is only right to state some simple means of treatment which a patient may herself adopt, when skilled advice may be for the time beyond her reach—some means which cannot be hurtful no matter what may be the exact cause of the disorder, and which will give some relief in most cases, and in some may be sufficient for a cure.

The first thing, then, to be done is to restore, if possible, a good measure of general health.

The means to that end are good food of sufficient quantity and easily digested, the regulation of the bowels, avoidance of overwork and excitement of any kind, a fair amount of exercise, exercise short of fatigue, and plenty of fresh air—sea-air is specially beneficial. Concerning food the mistake must not be made of living on slops, corn-flour, arrow-root, and foods of that kind mainly. Milk should bulk largely in the diet, but also other animal foods, soups, eggs, fish, and a fair daily supply of butcher-meat. A great many women make a grievous mistake in avoiding as much as possible such animal foods, and half-starving themselves on sloppy diet. For the regulation of the bowels nothing is better than a wineglassful or thereby of the Hunyadi Janos mineral water taken the first thing in the morning. Over and above this some quinine and iron tonic will be of much value in depressed states of health.

As regards applications to the affected parts one thing can be very strongly advised, namely, the use of hot-water injections. To obtain the full benefit they must be given in the way to be described. The patient lies across the bed, a pillow under the back to raise the hips, the feet resting on chairs. A piece of mackintosh cloth is placed under her, and arranged to cause water to flow off into a pan at the side of the bed. The injection is given by someone assisting her. About one gallon of hot water should be used, water comfortably warm to the hand, by the thermometer about 110° Fahrenheit. A vaginal douche (Plate XXXII) is employed, ending in a nozzle of glass about 6 inches long. The end of this tube should not have a single opening at its point. It should end in a blunt form, and several openings should exist round it. The douche being properly filled and in good working order, the glass end is passed into the passage gently near the back wall and directed backwards. It should be passed in as far as it can easily slip, and then the water should be caused to flow steadily and slowly. Owing to the hips being raised the passage will become filled with the hot water before any flows out, and this is what is desired by the method. At the same time care must be taken that there is no obstacle to the free escape of the water as soon as it has filled the passage. The douche should be given in this way at bed-time, every night or every second night. A little patience will render it comparatively easy, and the patient will speedily discover the ease and comfort it affords. If there is any insuperable difficulty in giving it in this way, the patient must content herself by using an enema syringe while she sits over a pan or bath, but the water should be used at the same heat.

At the outset the water, whether employed with douche or enema, should contain some disinfecting or antiseptic solution, such as lysol, 2 table-spoonfuls to a ewerful of water, or carbolic acid in the same proportions, or a tablespoonful of boracic acid. Later an astringent substance, such as sulphate of zinc, alum, or iron-alum may be added to the water, about 20 grains of either to the jugful of water. As a rule, however, the hot antiseptic douche, if properly given, will do all that an astringent injection could do.

Care should be taken in the keeping of the douche or enema. It should never be tossed carelessly aside into any box or drawer. It is too apt in this way to become so soiled as to become itself a source of mischief when used. It can be well kept in the large ewer or bedroom jug, which is used for douching purposes, lying there in a coil, and the mouth of the jug should be covered with a clean cloth secured by an elastic band or a cord. If the jug has been thoroughly scrubbed with soap and water and a brush, as it ought to be, before being used for the douche, then it should be a perfectly clean receptacle for the douche, which it keeps in a manner ready for use. If the douche and jug are to be put away for a time, then the cloth-covered jug may be further protected by stout paper. If a douche is going to be used again, after lying aside for a period, it should be first boiled, as directed on p. 634, any vulcanite parts being first removed, as boiling water softens them and would alter their shape. They should be immersed for some hours in an antiseptic solution.

Ulceration of the Womb is a phrase that strikes terror to the ears of most women. It used to be far too commonly employed, and is probably still. The condition which it is frequently used to signify is practically that already described. Owing to chronic swelling, the inner wall of the neck of the womb and its mouth become thickened, prominent, and too freely supplied with blood, but in the vast majority of cases to which the name is given there is no such eating away of the substance of the part as the name would imply.

The treatment, so far as the patient can resort to it, is such as has been described under inflammation. One other thing she may be able to do, and that is, take a little ball of cotton or lint, soak it in glycerine, and then push it up the passage as far as possible. *She must be careful to remove it next day or within two days,* and after syringing with warm water may replace it by a fresh one. If it is difficult of removal syringing will readily bring it down. A medical man would employ further treatment by directly painting the affected part with one or other of a variety of applications.

TUMOURS OF THE WOMB.

Three forms of tumour of the womb are of comparatively frequent occurrence, namely **polypus, fibroid or fibrous tumour,** and **cancer.** There is one broad distinction between the two former of these and the latter, and that is, that the two former are simple tumours, formed of overgrowth of some part of the substance of the womb, not destroying the substance and not necessarily dangerous to life; while the latter is a growth foreign to the true substance of the part, invading and destroying it, and tending inevitably to death within a comparatively limited period.

The Polypus varies in size from that of a small pea upwards, and may be an overgrowth of the lining mucous membrane, or an overgrowth of the wall beneath the lining membrane. It projects into the cavity of the womb, being connected to its walls by a longer or shorter stalk. By its presence a polypus causes a greater determination of blood than is proper to the womb, and thus gives rise to bleeding, especially to excessive loss at the monthly periods. It also excites contractions of the womb, and so occasions painful spasms and pains in the back and loins. It may block the opening of the womb, and by causing difficulty of escape of the monthly discharge cause the illness to be attended by severe pain.

The **treatment** is surgical, and consists in the removal of the polypus.

The Fibroid Tumour, Fibrous Tumour, or **Fibromyoma,** as it is also called, may occur in various situations, and may be of a great variety of size. It is a simple overgrowth of part of the wall of the womb. It may project into the cavity of the womb like a polypus, or it may project in the direction of the outer wall towards the cavity of the belly, or it may remain embedded in the substance of the wall, difficult to distinguish from simple enlargement of the womb. In size such tumours vary from that of a pea to that of a human head. They are extremely common, but may exist without giving any indication of their presence. They rarely appear before the period when the monthly illness begins. Their growth is encouraged by the regularly recurring increase in blood supply to the womb by the monthly illness, and also by the stimulus of sexual excitement. Marriage will thus tend to stimulate the growth of one already present, while the presence of one may be a cause of sterility: the fact of sterility will also encourage the growth. As a rule they cease to grow when the child-bearing period has passed, and thus if this age is reached a woman troubled with such a tumour may look for a gradual relief from its symptoms.

The **symptoms** are of two kinds: (1) those due to the mere pressure of the growth on surrounding parts, the chief of which is pain; and (2) those due to the increased blood supply to the womb which the tumour occasions, of which the chief is excessive loss of blood during the monthly illness, or a more or less continuous loss of blood.

The pain may be of a spasmodic character due to the tumour stimulating contractions of the womb, or it may be of a neuralgic form due to pressure on nerves, or it may be a dragging pain in the back and loins, a constant wearied feeling, easily increased by walking, and also by carriage exercise when the tumour is of any size. Other pressure symptoms may exist, such as confirmed constipation from pressure on the bowel, frequent desire to make water, or inability to make water, or pain in making it, swelling of the legs, &c., and such symptoms are all liable to be aggravated at the monthly period owing to the increased size of the womb at that period. Then the monthly illness may be attended with great pain owing to the tumour blocking the escape of the discharge, and the presence of the tumour also occasions not unfrequently great pain during sexual intercourse.

Excessive flow of blood may not be marked in cases where the tumour is embedded in the walls of the womb or bulging towards the cavity of the belly, but is likely to be the main symptom when it bulges towards the cavity of the womb itself. Usually it is a prominent symptom, and, as has been said, the loss of blood may not be limited to the period of the monthly illness, but may go on almost without ceasing.

The loss of blood may be so excessive as to become the grave feature of the case.

Treatment.—It is to be remembered that the tumour is a simple one, in no way to be regarded with apprehension such as a cancerous tumour would excite. It may be a constant worry and cause of suffering from pain, &c., but it need not prove fatal. The loss of blood occasioned by its presence is the serious part of it, since this may threaten life, either directly or by exhaustion, or by laying the patient open to other disease from the general bad health arising from it. The object of treatment is to relieve the symptoms as much as possible till the child-bearing period is past, when a gradual cessation of the patient's trouble is likely to ensue.

The tendency to lose blood may be restrained by avoiding everything that would increase the blood supply to the womb. As much rest as possible during the monthly illness is, therefore, desirable, and, if the patient be married, restraint as much as possible from the exercise of sexual functions. Pregnancy might be a serious complication, though occasionally a fibroid tumour has almost or entirely disappeared after pregnancy and a successful confinement. Unmarried women should remain so if they are aware of the existence of such a tumour. Just before the monthly illness, opening medicine in the form of mineral water or effervescent citrate of magnesia is beneficial, and nourishing but unstimulating diet, with avoidance of spirituous liquors, should be the rule.

If the bleeding be excessive the effort to limit it should be made by taking the liquid extract of ergot, from one-half to a whole tea-spoonful in water thrice or four times daily; and if excessive loss of blood during the period has been the rule, this should be taken for a day or two before the illness begins, and for a few days after it has ceased. To relieve pain a pill of one-third of a grain of extract of Indian hemp may be occasionally taken, or 30 grains of bromide of potassium dissolved in water. Iron tonics taken during the intervals are valuable for restoring or maintaining the general health. Pain is often also relieved by the use of some support to the uterus in the form of a pessary if such can be adjusted for the purpose.

If the loss of blood be so excessive or persistent as to threaten serious consequences, a surgeon would probably propose an operation for the removal of the ovaries. The ovaries being removed, the monthly illness ceases, and thus nature's method of relieving the patient is anticipated.

Cancer of the Womb.—This disease may occur in the body of the womb or be limited to the neck (p. 619). The former case is comparatively rare. Cancer differs from fibroid and other simple tumours in that it destroys the substance of the organ in which it is situated, spreading through it and from it to other parts, and tending also to pass to other organs. If it be removed it is liable to recur. For these reasons a cancerous tumour is called malignant as opposed to simple. The womb is the commonest seat of cancer in the female, and its occurrence there is very frequent. It rarely occurs below the age of twenty years or above that of sixty, and is most frequent between forty and fifty. It has an inevitable tendency to death, and from one to two years is the average period of life after its appearance.

Its **cause** it is impossible to state. That it has a tendency to occur in families seems undeniable, and some distinguished authorities believe it occurs chiefly in women who have borne children, and in whom the neck of the womb has been torn. Such local irritation, however, may be only the exciting cause of the appearance of a tumour to which the woman was already disposed.

There are several varieties of it. It is common as an affection of the lining surface of the neck of the womb, gradually eating into and destroying the deeper parts, occasioning ulceration and thickening extending inwards.

Its **symptoms** are mainly pain, loss of blood, and discharge. The pain may not arise till the disease is far advanced, and is of a stabbing or burning kind, shooting up to the loins and down the thighs. It is generally worse at night. It is the loss of blood that often arouses suspicion. It may occur from apparently trifling causes, and though it may be slight to begin with, it becomes at length a perpetual drain upon the body. As a consequence the person comes to have a characteristic appearance, the skin becoming of a peculiar sallow or dirty yellowish colour. The discharge is watery, tinged usually with blood, extremely irritating to the skin of the external parts, and of a very offensive smell. The disease may ulcerate its way into the bladder or bowel, so that water constantly dribbles away, or motions are passed from the genital passage.

The whole system becomes affected and deranged, and if death does not occur directly from loss of blood, exhaustion is frequently the consequence.

Treatment.—If the disease be detected early enough, its removal by the knife may effect a cure, or at the least will for a season stop suffering and prolong life. Many methods of cure by medicines have been praised at different times, but all have been in the end found comparatively useless.

The foul discharge may be relieved by the injection with the enema syringe of water containing 10 grains of thymol to the ounce, or of a 2½-per-cent solution of carbolic acid.

To relieve pain opium in some form is the remedy. But it should be used under medical advice.

Everything possible should be done to maintain the patient's general health by plain nourishing food, the use of iron, quinine, and similar tonics, and the regulation of the bowels by such gentle medicines as a mineral water. Stimulants should be avoided as far as possible.

DISPLACEMENTS OF THE WOMB.

Displacements of the womb are exceedingly common, commoner than is generally supposed, frequently existing without giving rise to any marked symptoms. At the same time the displacement may give rise to many and pronounced symptoms, which no treatment does anything to relieve except that of replacing, as nearly as possible, the womb in its original position.

The womb is suspended, as it were, in the middle of the pelvic cavity (p. 63), with the bladder in front of it, and the termination of the bowel behind it. It is maintained in its position by its attachment to these organs, and by bands or ligaments of its own, and in its situation is freely movable in various directions. The upper end of the body is directed upwards and forwards, and the mouth downwards and backwards, so that, when the person is in the erect position, it may be said to incline forwards.

Prolapse of the Womb.—The womb may not be maintained at its ordinary level, but sink somewhat *downwards*, for example, because of enlargement or congestion rendering it too heavy for its supports, or because the supports have become stretched and weakened. This is called **prolapse**, and will vary in degree according as the womb sinks lower and lower. If it sink greatly, the mouth of the womb may appear at the external opening, and, in very extreme cases, it may appear entirely outside, which form is called **procedentia**. It naturally will drag down with it the wall of the bladder to which it is attached in front, and the wall of the bowel to which it is attached behind.

Retroversion.—Further, instead of being inclined forwards, as in the ordinary position, the womb may be tilted backwards, in which case the body looks backwards and the mouth forwards, and this backward tilting also varies in amount. **Retroversion** is the name applied to this displacement. The womb itself, though inclined backward, remains straight.

Retroflexion, however, is a condition in which the organ is bent upon itself, *bent* backwards on itself, so that the body of it is directed backwards, the mouth maintaining pretty nearly its proper position. It is doubled on itself.

Anteversion is the term when the organ, remaining straight, is unduly tilted forwards, so that the womb tends to lie across the cavity.

Anteflexion signifies that it is curved or bent forwards on itself.

The **causes** of such altered positions are numerous. Congestion, overgrowth, the presence of tumours, &c., adding to the weight of the organ, tend to displace it. A very common cause of this kind arises when a woman begins to go about too soon after a confinement. The womb has not had time to return to its natural size, and its supports, stretched and weakened by the pregnancy, are unable to bear up the unusually heavy womb, and thus it assumes an improper position. General ill-health may so diminish the vigour of the supports, and diminish the tone of the womb itself, as to occasion a "displacement." Further, any undue pressure may force it out of place, and if this be long continued it does not get a chance of returning to its natural place. Undoubtedly a great cause of such pressure is the undue weight of clothes and tight lacing. These diminish the size of the belly cavity by pinching in the waist. The bowels are pressed upon, and to find room press downwards on the womb, &c., forcing it out of position, and *keeping it out of position.* The pressure of a tumour in the belly may act in the same way. A tumour pressing upwards from below may also displace the womb, but in a different direction. As another example, the frequent existence of a distended bowel or overfull bladder, apt to occur in women, may occasion it. Undoubtedly falls, violent exertion, and such agencies are often at work in producing such disturbances of position. In women who have borne children, the womb is often deprived of its due support from below by rupture of parts during labour, and it is then apt not to be duly maintained in proper place.

It ought, also, to be noted that a womb, displaced from any cause, is liable to be the seat of congestion and other disorders, because of the disturbance to the proper circulation of blood through it which the displacement occasions, and such congestion will then tend to increase the departure from the natural situation.

Symptoms.—Unless in cases of prolapse, where the mouth of the womb appears externally, there are really no symptoms by which a patient could decide for herself the nature of her trouble. There are likely to be many which would lead her to conclude that something was wrong with the womb, but none which would enable her to conclude what was the real nature of that something. The existence of a displacement and its kind can only be determined by a skilled medical man, after he has made an examination by introducing his finger into the passage, and thus ascertaining the position of the organ.

The symptoms that point to such uterine trouble are backache, pains in the loin, discharge, perhaps pain at the monthly illness. A womb displaced backwards is liable to press on the bowel and cause constipation and piles; a womb displaced forwards is more apt to give rise to bladder troubles, pain in making water, frequent desire to pass water, &c. &c. There is often discomfort or difficulty in walking. Indigestion is extremely common and persistent, and is sometimes the only result of a slight displacement. Indigestion so caused is almost certain to defy any treatment directed to it, but speedily disappears if the displacement be detected and got rid of. Sterility is common in all forms of displacement, but particularly in those in which the uterus is bent on itself, for the bend blocks the canal of the womb and prevents the passage upwards of the seminal fluid. Further, nerve troubles are in many cases the main pronounced symptoms of such disorder, which, like those of digestion, defy all treatment unless the uterine condition be attended to. Such disturbances of the nervous system are more apt to occur in young unmarried girls; and the hysterical condition into which young excitable girls are sometimes brought by such a cause is not easily overcome.

The treatment of such conditions is in many cases not attended with much difficulty, while in other cases it is by no means easy. In all, as a general rule, very great relief can be afforded, even though a permanent cure is not obtainable. But the treatment can only be properly undertaken by a medical man. It consists in restoring the womb to its natural position, if that is possible. Sometimes it is not possible, because of the very long duration of the displacement having caused the womb to become fixed in its altered position, or because of inflammatory adhesions binding it down. It is very often possible for the surgeon to replace the womb simply with the fingers, and more often with the aid of a long slender rod, on a handle, called a sound, the use of which, in skilled hands, ought not to be attended with any considerable pain. The second element in the treatment consists in the introduction into the passage of a small instrument, called a pessary, made commonly of vulcanite, but also of celluloid, or india-rubber, in the shape of a large ring, which is so placed as to support the womb in its restored position. The shape of the pessary varies with the kind of displacement. If it is properly adjusted, it should occasion no inconvenience whatever, the patient should, indeed, be unable to perceive its presence, and it does not require any alteration in ordinary ways of life, does not, for example, necessitate a married woman living a single life, while it remains in the passage. The third element in the treatment consists in the endeavour to restore vigour and tone to the parts, so that in course of time the pessary may be removed with some hope of the womb remaining in its restored position. Such treatment necessitates attention to the bowels, to the food, to proper exercise, fresh air, &c. Tonics will aid the endeavour; but the suitable tonic depends on circumstances to be judged by the physician.

Anyone who is wearing such a pessary ought to return from time to time to her medical attendant, and ought to see him without delay if any signs of its presence irritating the passage arise. Probably the pessary will require to remain six or eight months, but it ought not to remain longer without the medical man's sanction. Patients have been known to forget altogether the presence of the instrument, and to continue wearing it for very prolonged periods, till it became fixed, impacted by incrusted remains of discharge, urinary sediment, &c.

While the instrument is being worn, frequent use of the injection by an enema ought to be persisted in. This will not only aid in restoring the vigour of the womb and neighbouring structures, but by the constant cleanliness will prevent irritation arising from the presence of the pessary. The daily use of the injection is strongly urged. The injection had better be not of warm water only, but of warm water with some added carbolic acid, of a strength equal to one ounce of the acid to every three or four pints of water. The pessary is simply to be regarded as affording a mechanical support till the tendency of the womb to return to an abnormal position is overcome.

The form of displacement most readily treated by pessaries is the backward displacement, the backward tilting of the womb, and happily this is the commonest of the displacements. The forward displacement is much less easy to treat in this way, from the difficulty of adapting an instrument to this situation. Fortunately it is not nearly so common a form.

Some cases of prolapse are readily benefited by treatment on these lines, others are extremely troublesome. For the most aggravated cases of prolapse, an operation has been adopted which has yielded good results. It is not a serious operation, and by it the ligaments of the womb are pulled upon and tightened, "the slack is pulled in," so to speak, and the womb thus restored to its proper height and held there.

DISEASES OF THE OVARIES.

Inflammation of the Ovaries and Ovarian Pain (*Neuralgia*).—Inflammatory diseases of the ovaries are not easily separated from similar affections of neighbouring parts. Moreover, the ovaries share in disorders of the womb and in diseases of parts in their neighbourhood, the removal of which will usually be accompanied by the cure of the ovarian disorder.

Any cause tending to induce congestion of organs in the lower part of the belly will produce congestion to a greater or less extent of the ovaries and set up symptoms specially referred to them. Thus sudden stoppage of the monthly flow is such a cause, and inflammation occurring after child-birth.

The **symptoms** that point to the ovaries are pain, sometimes excessively severe, in the region of one or both ovaries, that is about the middle of the groin (see Fig. 113, p. 241). The slightest pressure in this position is very painful. In chronic cases of inflammation the pain is constant and wearing, usually worse at the period of the monthly illness. In some cases it is scarcely perceived at the periods, but returns in the middle of the interval between the periods. The pain is increased by standing, walking, and by sexual intercourse. It sometimes shoots down the thigh. The monthly illness is of an unusual kind, excessive or scanty or very painful. Various nervous pains are experienced throughout the body, and a highly nervous and hysterical condition may result from the chronic form of the disease.

In some cases the pain is neuralgic in character, and the term neuralgia of the ovaries has consequently arisen.

The **treatment** depends on the cause of the affection. It can only be said here that anything likely to excite congestion of the organs in the lower part of the belly is to be avoided. Constant standing, much use of the treadle sewing-machine, of the harmonium, &c., ought to be avoided. Good food, fresh air, sea-air, and sea-bathing are valuable. Hot-water injections, as advised on p. 655, may be tried. The evils of the use of laudanum or other preparation of opium, and of alcohol, are very great, and the inducements to their employment many. They must be strenuously avoided.

Tumours of the Ovary (*Dropsy of the Ovary*).—While there is a variety of solid tumours of the ovary, the common tumour is one containing fluid. It is a cyst, or sac, of every variety of size, some weighing as much as 30, 50, or upwards of 100 pounds. Its contents may be a watery, clear, straw-coloured fluid, or a fluid more gluey and tenacious and of varying colour. While the tumour may grow slowly, it has been stated roughly that the average duration of life after its beginning is under three years. These tumours are most common between the ages of twenty and forty years.

Symptoms.—In the early stages there may be practically no symptom, and the first indication may be the enlargement of the abdomen. The enlargement may be mistaken for pregnancy, though it is usually more or less rapid than that of pregnancy; and this mistake is more apt to be made if the monthly illness ceases or becomes scanty and irregular. As the tumour grows, the patient becomes thin and exhausted, and disorders of the bowels arise, increasing the exhaustion.

Treatment.—There is only one form of treatment of any value, namely removal of the tumour by surgical operation. It is an operation now attended by very great success when skilfully performed, and when undertaken in time before the patient's powers are exhausted. Withdrawing a quantity of the fluid by tapping is not now so common a method of treatment as formerly. It affords only a temporary relief, the sac filling up again in a short time, and if frequently performed it may be a serious hindrance to the operation for removal, by causing adhesions between the walls of the sac and those of the belly cavity.

DISORDERS OF THE MONTHLY ILLNESS (MENSTRUATION).

Absence of the Monthly Illness (*Amenorrhœa*).—Strictly speaking, the term amenorrhœa, meaning want of the monthly discharge, is only applied to those cases where the monthly illness has never appeared at any time. It is, however, also applied to cases in which the monthly illness has been present, but has after a time disappeared. This latter condition is more correctly termed **suppression of menstruation.**

It is necessary to notice this distinction, for, if a girl has reached the age when the illness might be expected, and it has not appeared, it is sometimes necessary to assure one's self that the non-appearance is not due to some obstacle to the escape of the discharge externally, the illness actually occurring, but the discharge being retained.

Absence of the Illness through Retention.—In the virgin condition there is a membrane, called the **hymen**, which stretches across the lower end of the genital passage. The membrane is, as a rule, not complete, a small opening existing in the centre, through which discharges from the womb escape. But in some cases, not frequent, the membrane is complete, and thus no discharge can escape. The obstruction may exist at the mouth of the womb itself. In such cases the symptoms of the monthly illness appear without discharge. At regular intervals pains in the back and sides occur, and with each return they increase in severity. The patient has a feeling of weight, and grows pale and sallow. The retained discharge, accumulating from month to month, causes the belly to enlarge and a tumour to appear, which undergoes regular monthly increase. The girl's friends, putting the absence of discharge and the enlargement of the abdomen together, suspect pregnancy, and many an innocent girl has thus come under unmerited rebuke.

It is even possible for such an obstruction to occur in some part of the womb or passage after the illness had become established, and this must always be borne in mind.

This condition is remedied by surgical interference, opening a way for the retained discharge to escape. Such cases are, however, always attended with risk.

Complete absence of monthly illness may also be due to some arrest of development of the genital organs. There are thus cases in which the ovaries or womb have been absent, or present in an undeveloped condition. In absence of the ovaries the girl does not exhibit the changes in form from girlhood to womanhood. The breasts remain small and the hips narrow, the voice is manly and harsh, and the appearance becomes masculine.

Absence of the Illness through Suppression, that is after the illness had become more or less regular, may arise from a variety of causes. It may depend upon a condition of general health or a poor quality of blood (see ANÆMIA, p. 313). The feeble condition of general health is often the result of over-work, over-pressure at school, improper quantity or quality of food, want of fresh air, confinement in the bad atmosphere of a crowded work-room, or of some acute disease, &c. The opposite condition of too full-bloodedness may also produce suppression of the illness. Disease is another cause, and especially consumptive disease of the lungs, disease of the kidneys, and digestive and nervous disorders. Emotion, fright, or grief sometimes occasions the disturbance. The illness may be suddenly arrested by cold.

The absence from failure of general health is sufficiently evidenced by the paleness of the patient. She is wanting in energy, listless and languid. These cases are readily enough separated from those due to cold or full-bloodedness.

The **treatment** is regulated by the cause. It is sufficient to state the kind of treatment needful in the variety dependent on the general health, and that due to sudden suppression owing to cold, &c. It includes good nourishing food of a plain kind, containing a fair proportion of animal food, sweet milk, eggs, fish, fowl, beef, soups, &c. The bowels must be kept regular, a saline medicine, such as seidlitz, Hunyadi

Janos mineral water, or the effervescing citrated magnesia being given, if required. Especially is it necessary to insist upon abundance of life in the open air, and moderate exercise. While overwork is extremely hurtful, the absence of some bodily or mental occupation is also injurious. Change of air and sea-bathing are strongly advised, and, to those who can afford it, a visit to some of the Continental spas is recommended, especially Kissingen in Bavaria, Kreuznach in Rhenish Prussia, Schwalbach in Nassau, Spa in Belgium, Bourboule in France. In England Woodhall Spa, in Lincolnshire, is recommended. Much standing, stooping, or prolonged sitting is to be avoided. As to medicines it is impossible to state what suits every case, but tonics belong to the kind required. Iron and arsenic are particularly valuable.

The following prescription may be employed:—

Reduced Iron................	36	grains
Arseniate of Iron,..........	1½	,,
Extract of Nux Vomica,.	3	,,
Sulphate of Quinine, ...	12	,,
Extract of Gentian,........	24	,,

Mix and divide into 18 pills.

A half gradually increased to one pill is to be taken thrice daily after food.

These pills must always be taken after food, never on an empty stomach.

Further, the full dose is not to be taken all at once. To begin with, let a few of the pills be divided into two, and let a half be taken after meals thrice a day for two or three days, then let a half be taken after two meals and a whole one after the principal meal, and so let the dose be increased till at the end of a week three pills daily are being taken.

It is important also to notice that the use of the pills must not be stopped suddenly but gradually, a half pill less being taken for a couple of days, then another half less, and so on till in a week their use is stopped altogether.

Arsenic is apt to disagree with some stomachs. In such cases it may be altogether left out of the pills.

While these directions have been given, it is desirable to say that no unskilled person should attempt to treat such a disorder if skilled advice is obtainable.

Sudden suppression, as may arise from cold, usually happens in full-blooded people, and is accompanied by severe pain in the back, quick pulse, feverishness, flushed face, headache, &c. Let the patient's feet and legs be placed in a hot mustard bath for half an hour. She should be then put into a warm bed with warm foot-pan, and should have frequent mild warm drinks, following a large dose of opening medicine, castor-oil, for example. If this is not sufficient, and the case seems urgent, fever being high, place hot mustard poultices over the lower part of the belly, and give 5 to 10 grains of Dover's powder according to age.

Irregularity or Scantiness of the Monthly Discharge, in which the discharge occurs after more than usually long intervals, or at irregular intervals, or in which it occurs regularly but in small quantity, is commonly dependent upon conditions of the general health similar to those producing absence of discharge, and is to be treated on similar lines.

Excessive Monthly Illness (*Menorrhagia and Metrorrhagia*).—The monthly illness may be excessive, because occurring too frequently. Such conditions indicate a depressed condition of general health, and are also associated with disordered states of the womb. They are not uncommon at the period of change of life. The tonic treatment recommended for absence of the illness is likely to prove beneficial.

There are, however, two special forms of excess. One of these is called simply profuse menstruation, what is meant being that the discharge is too free or lasts for too long a time, returning at the regular periods perhaps. The proper term for this is **menorrhagia.** The other form is not strictly discharge at the monthly periods, but a loss of blood occurring at other than the monthly period, at least a discharge of blood from the womb, occurring independent of the monthly period. This is called **metrorrhagia.**

The first form, that of excessive loss at the period, occurs under various circumstances. It must be observed, however, that there is no absolute quantity of discharge to be regarded as the healthy standard (see p. 621). Each woman knows what, under ordinary circumstances, she is accustomed to, and that is her standard. The excessive loss may depend upon bad conditions of health, arising from Bright's disease of the kidney, scurvy, consumption, &c. Commonly it is a symptom of chronic disease of the womb. It is sometimes the only symptom of fibroid tumour of the womb (p. 660). In cancer of the womb, polypus, displacement, congestion, and in many other alterations in structure it is present.

The excessive loss produces a blanched appearance of the patient, and according to the degree of excess is more or less exhausting. The second form is met with under similar conditions, and the first often leads up to and merges into it.

The **treatment** of both forms is practically identical. The patient should rest in bed as much as possible during the period, undertaking no exertion. If the loss of blood is great and threatening, whether during the period or not, she must lie in bed perfectly quiet and lying on her back. Mild but nourishing diet in small quantities should be given often—milk, light soups, &c. The very valuable and most readily obtainable drug is ergot or spurred rye, in the form of the liquid extract. A half to one tea-spoonful is given in water or syrup every third hour as long as necessary. Another useful drug is the tincture of witch-hazel (*Hamamelis virginica*, vol. ii, p. 368), in doses of 5 drops in water every third or fourth hour. A medical man would, in urgent cases, plug the passage by inserting pledgets of soft cloth, sponge, silk handkerchiefs, &c. In the intervals between the periods good nourishing food, bracing air, moderate exercise, &c., are valuable, as well as the iron tonic advised for absence of the discharge on the preceding page.

In certain cases of persistently recurring attacks, due to tumours, and threatening life, a surgeon might recommend removal of the ovaries, or other operative interference.

Painful Monthly Illness (*Dysmenorrhœa*).—Painful menstruation is exceedingly common, and many women who suffer severely at each period seek no advice nor relief, because they believe a certain amount of pain is a natural accompaniment of the illness. This is not so. Any actual pain is a departure from the proper state of affairs, and ought not to be endured, if it can be got rid of.

The **causes** of the pain are numerous, just as the cause of every other menstrual trouble may depend on a variety of circumstances. In one set of cases the cause is a mechanical one, and consists in some obstacle to the easy flow of the discharge, undue expulsive efforts of the womb being thereby occasioned. Thus the canal leading from the womb may be very small or contracted, the womb may be displaced and bent, so that the canal is encroached on, or at one point blocked by the bending, clots may form readily, and stop the way or require specially violent efforts to expel them, or the way may be barred by a tumour. All these instances come under this class of cases as mechanical causes of painful menstruation. Another set of classes often occurs in which the pain is of a congestive or inflammatory sort, and in others shreds of membrane and casts of the womb are expelled. In a fourth set the pain is more neuralgic in character, not seeming to depend on any special condition of the womb, while the pain in some cases arises from the ovaries.

The commonest cause of painful menstruation is some mechanical obstruction to the flow of the discharge, due either to narrowing of some part of the canal of the womb, or to some displacement. The occurrence of any clots or shreds of membrane will certainly increase the pain by the difficulty of their passage along the narrowed canal.

The **symptoms** of this variety are very intense pain, sometimes agonizing, leading in some cases to fainting, hysterical attacks, or even delirium. The pain often begins before the discharge, and is relieved when any quantity passes, as it sometimes does, in gushes. It begins deep in the belly, but radiates to the groin, thighs, and back. Headache and vomiting are common, and there is often tenderness over the womb and ovaries. The pain may persist throughout the illness. Morover, the obstacle to the flow tends to produce a congested condition of the womb.

The cases dependent upon congestion have similar symptoms.

Those accompanied by discharge of shreds of the membrane are recognized by the presence of the membranous fragments, and the pain is most intense just before the passage of the membrane, after which it is relieved. When the pain is more ovarian than belonging to the womb, it usually begins a few days or a week before the discharge appears, and may cease with its appearance. It is felt in the situation of the ovaries (see Fig. 113, p. 241), in the groin, and commonly on the left side, and there is tenderness over this position. Vomiting and hysterical attacks are common in it. Probably there are few cases really neuralgic in character, those classed thus being likely due to some obscure condition of the ovaries.

Treatment.—The general treatment of painful menstruation consists in rest in bed during the attack, and the employment of hot applications, hot-water bottles, hot fomentations, &c. Great relief will be experienced, in many cases, by the patient taking a hot bath, lasting for twenty to thirty minutes, before going to bed, on one or two nights before the illness is expected. The pain will be relieved by some preparation of opium or other similar soothing drug. The following pill is good for that purpose:—

Morphia,	$\frac{1}{12}$th	grain.
Extract of Indian Hemp,	$\frac{1}{3}$rd	,,
Extract of Hyoscyamus,	$\frac{1}{2}$	,,
Extract of Gentian,	1	,,

Make into one pill.

Two or three of these may be taken at intervals of two or three hours after each pill.

Instead of this a dose of 10 to 15 drops of laudanum, with 5 drops of tincture of belladonna, may be used.

If the pain is felt over the ovaries, 20 grains bromide of potassium, dissolved in water, may be tried every three hours.

While such a remedy is often necessary, the danger attending the use of any preparation of opium must be strongly pointed out. The desire for the drug becomes strong, and it is used more frequently in ever-increasing quantities. Many women contract a fatal opium habit from using it at such periods. In such a time of suffering, also, stimulants are sought, and relief is obtained from them. The craving for them grows just like the craving for morphia. Thus too many women have become the slaves to opium or whisky, which was originally taken for the relief of urgent suffering.

Under such circumstances it cannot be too strongly urged that everyone suffering in this way should not attempt to treat herself, but should seek competent advice. It is probable that a skilled medical man would discover some unusual condition, which was the cause of the pain, and which he might be able to rectify without the use of drugs that might in the end prove more disastrous than the original ailment. Thus a displaced womb could be restored to its proper position, and perhaps the painful menstruation could be cured, a contracted passage could be widened, and other unhealthy conditions might be got rid of.

During the interval between two illnesses much relief may be obtained by attention to general conditions of health. Good plain food should be the rule; a daily movement of the bowels ought to be obtained by mild opening medicine, if necessary—for example, a wineglassful of Hunyadi Janos mineral water each morning on an empty stomach. Opening pills should be avoided. The patient should be warmly clad, with flannel next the skin, and it is necessary to avoid all undue tightness of dress. Fresh air, moderate exercise, avoidance of fatigue are all of the utmost consequence. Any gouty, rheumatic, or weakly condition of health, such as anæmia (p. 313), needs to be treated.

AFFECTIONS OF THE BLADDER IN WOMEN.

Painful, difficult, or frequent passing of water very often occurs in women as a consequence of some affection of the womb or genital passage. Inflammation of the passage (p. 655) is apt to spread up to the canal leading to the bladder, and cause frequent desire to pass water, an act which is likely, under these circumstances, to be attended by a hot, smarting, or burning pain. The same condition may cause spasm at the neck of the bladder, and lead to inability to pass the urine. Specially likely is it that an irritating discharge will set up such a condition and lead to much pain and discomfort, a result that constant care and cleanliness would do much to avoid. A displaced womb, by pressure on the bladder, will readily set up an irritable condition, manifested by pain and a frequent desire to pass water, or will block more or less the passage from the bladder and occasion difficulty of micturition, as the act of passing water is called. Tumours connected with the generative organs may have similar effects. Besides the prominent symptoms of frequent or painful or difficult micturition, there is often produced considerable difficulty in walking, and in turn the walking aggravates the other symptoms. Painful and difficult or frequent micturition may also be quite independent of any disorder of womb or genital passage, and may be occasioned by some unnatural state of the urine, undue acidity, or otherwise altered characters, the result of disease of the kidney or bladder or some constitutional state.

Treatment.—Rest and the use of hot applications give very speedy relief. Heat may be applied in the form of hot-water injections, hot cloths, or hot bottles close up to the parts, or the patient may sit down in a hot bath. Medicated pessaries are also of great value. These are made of cacao butter, in the shape of miniature sugar-loaves, some soothing drug being mixed with the cacao butter. The best are those made with extract of belladonna. Each pessary should contain 1 to 3 grains of this extract. The pessary is pushed well into the genital passage, a diaper is then put on, and the patient should rest for some time. This may be employed after the hot-water injection, bath, or fomentation. But the patient must bear in mind that, though such treatment relieves for the time, it is necessary, if the cure is to be permanent, for any cause of the disturbance that may be present to be found and removed.

NERVOUS DISEASES OF WOMEN.

HYSTERIA, CATALEPSY, TRANCE, AND ECSTASY.

Hysteria (Greek, *hustera*, the womb).—This is so remarkable and amazing a disease, having so many varied forms, and producing so many perplexing manifestations, that it is doubtful if any but the briefest notice of it is necessary in a work like this. It is a puzzle and plague to nearly every physician. It is apparently due to a peculiar nervous condition, not necessarily attended by any structural change or disease in the nervous organs. It does occur rarely in men, but is very common in women, most frequently between the ages of fifteen and thirty, and specially between the ages of fifteen and twenty. Very commonly it is associated with some disturbance of the genital organs, often slight in itself, but sufficient in the case of nervous girls to excite the manifestations of the disorder. In those liable to nervous disturbance it may be induced by too luxurious and indolent habits, by unfortunate surroundings, badly directed training, and various other causes. The fact that men are, though rarely, affected with hysteria, is sufficient proof that it is not necessarily related in women to the genital organs. Yet it must never be overlooked that some disorder, perhaps slight, of the organs of generation may be the exciting cause in women. In those liable to it, some such disturbance may occasion an attack, and the continuance of the condition may cause repeated recurrences of the attacks for a prolonged period. It is always, therefore, desirable to make sure that there is no such exciting cause at work, and this can only be done by a skilled physician.

Symptoms.—Hysteria may produce symptoms referred to every organ of the body. Symptoms related to the digestive organs are frequent, such as loss of appetite, obstinate vomiting, costiveness, excessive development of gas in the bowels. Disturbance of the heart, fainting, &c., are common. Spasmodic seizures and fits of various kinds are of common occurrence. It is a spasmodic contracting of the throat, often excited by flatulence, that gives rise to the feeling of a ball in the throat common in hysteria, and which has been called *globus hystericus.* Paralysis of the legs, loss of voice and speech, loss of feeling in various parts of the body, may all be the result of a hysterical condition. On the other hand, excessive tenderness of some part is frequent. Hysterical neuralgia, pain in a joint, in the breast, in the head, or over the stomach are common. The determination of the true nature of these disturbances is a matter of great difficulty. The mental condition of hysterical persons is also peculiar. They are nervous and excitable, prone to laugh or cry at trifles, with little control over their emotions, irritable, querulous, and quarrelsome.

Treatment.—The main element in treatment is firm and judicious control. If the person can be removed from the care of anxious friends and placed entirely under the discipline of strangers, much benefit will result. Hysterical convulsions can usually be cut short by dashing quantities of cold water about the person's face.

Catalepsy is a peculiar nervous condition, in which the patient loses all consciousness. At the same time the muscles of the body become so stiff that if a limb be placed in any position, no matter how unusual or difficult to maintain in ordinary circumstances, that position will be kept for a considerable length of time. The condition may last from a few minutes to several hours; and it may pass off suddenly or slowly. It is met with usually at the same age as hysteria, but it has occurred at as early an age as five years, and also in advanced life. During the attack the face is without expression and pale, and the movements of breathing are slowed, as also is the action of the heart.

The patient retains the position in which she was when seized. The muscles become rigid, and after this stiffness is overcome they become pliant, and can be moulded, as it were, like wax, into any position consistent with the integrity of the parts. This position will be maintained till the muscles become exhausted.

The surface of the body may become so cold that, the pulse and breathing being barely perceptible, the condition may be mistaken for one of actual death.

Recovery is usually gradual. Attacks may occur at regular intervals, or irregularly and at long intervals; and they may last a variable time, from a few minutes to some hours.

Trance is a condition resembling sleep, which usually comes on suddenly, without any apparent cause, and from which the person cannot be roused.

It occurs chiefly in women between the ages of twelve and thirty. It is a rare condition. The subjects of it are usually hysterical, and it occurs in some cases as the result of exhausting disease, or excited by some emotional disturbance. It may last for a variable period, from several hours to many weeks or months. During its occurrence the countenance is pale, and the limbs are relaxed. No attempt at rousing produces return to consciousness, while the attack lasts. In most cases the mental functions are in abeyance; but sometimes the person knows what is going on, though unable to make the slightest movement. The action of the heart is diminished, and the breathing reduced. The bowels are moved, and water passed, as in health. When the trance lasts for a lengthened period, the patient partially rouses at intervals, takes food in a mechanical way, and then relapses into stupor. Recovery may take place slowly or suddenly. Most cases recover.

During the attack the nourishment of the person must be maintained by nourishing injections.

Ecstasy is a similar condition to trance, in which, however, while the person is unconscious of impressions from without, the mind is possessed with some fixed idea, often of a religious character. The pulse and breathing are much reduced, the limbs remain in a particular attitude, and the countenance is pale, the eyes wearing a look of absorbed rapture.

DISEASES OF PREGNANCY.

STOMACH AND DIGESTIVE DISORDERS.

Derangements of the Stomach and Digestion are exceedingly common in pregnancy, are, in fact, almost constant, and are to be regarded as quite natural, if within certain limits. They depend mainly upon the sympathetic nervous relationship existing between the womb and digestive system; to some extent they are due to the pressure of the enlarging womb, and in some cases may be very marked because of displacement caused by the increased weight of the organ. They may occur throughout the whole course of the pregnancy, but they are often worse in the early months, beginning within a few weeks of conception, and being markedly relieved about the period of quickening, when the womb rises up into the belly. Perhaps the relief at this time is due to the greater room for growth thus afforded, and the consequently lessened pressure. Some women, however, scarcely suffer at all from such disturbances, while in others the distress is excessive. It also sometimes happens that a woman who has been much disturbed for two or three pregnancies passes through another almost without them, and the reverse also often happens.

Vomiting is one of the commonest of these disorders, and because of this is counted as one of the earliest and most usual signs of pregnancy (see p. 627). It is only when excessive that it should receive treatment, and it often happens that nothing gives relief. The patient should begin by maintaining the regularity of the bowels, which is best done by a wine-glassful of Hunyadi Janos mineral water, taken each morning before rising. This affords much relief if regularly taken. The effervescing citrate of magnesia is also useful. Then careful attention should be paid to the diet, as the vomiting may be largely controlled by finding the food that agrees best. Marked relief is frequently obtained by taking a cup of warm tea before rising, or by breakfasting in bed, and not rising for some little time afterwards. If such means fail, let the patient try the effect of taking small quantities of food often, and among the kinds of food milk, and milk with soda, are to be preferred, or milk and lime-water. Used in this way barley-water is highly spoken of. Frequent sips of iced milk may be found to allay the irritability. The only medicine to be recommended as a soothing agent is bismuth, which may be taken several times a day in 10-grain doses in water, or 1-grain doses of oxalate of cerium may be tried. Iodine is sometimes remarkably useful, 5 to 10 drops of the tincture being taken diluted with a wine-glassful of water, on the empty stomach, in the morning. A pessary of belladonna (see PESSARIES) has now and again succeeded when other means failed.

In some cases, happily very rare, the vomiting defies treatment, and is so persistent, with even the smallest quantities of food, that the patient becomes much exhausted, and brought into a condition of great danger. It is under such circumstances that a medical man would consider whether he were justified in inducing premature labour. This is a question for a skilled physician carefully to consider; it is here only mentioned as a last resort when the life of the mother seems threatened.

Acidity, Heartburn, and Painful Digestion are other forms of disturbance, and sometimes are the only forms, vomiting being entirely or nearly entirely absent. Bismuth in 10-grain doses, or half a tea-spoonful of the ordinary bicarbonate of soda (baking soda), or bicarbonate of potash, dissolved in water, is useful for these disorders, though the relief is only temporary. To the soda, dissolved in water, a tea-spoonful of sal-volatile (aromatic spirits of ammonia) may with advantage be added.

Constipation is best met by the use of the Hunyadi Janos mineral water, as recommended for vomiting.

Looseness of Bowels may occur every now and again. It should be met if possible by change of diet, the use of lime-water and milk, &c. If these means fail, 5 to 10 drops of laudanum in water may be employed, but this is to be had recourse to sparingly and with care.

Perverted Appetite or Loss of Appetite is another of the troubles of pregnancy. The craving for improper articles must be resisted, but a feeble appetite must be coaxed, and careful dieting will usually be sufficient to meet it.

DISTURBANCES OF BREATHING.

These are happily not so common as those of digestion. The mere bulk of the enlarging womb will occasion some difficulty of breathing. To meet this the patient must dress in the most suitable way. Difficulty of breathing is occasionally due to asthmatical attacks or bronchitis, and where such exists it would be well to obtain competent advice without delay. (Refer to pp. 363 and 366, where these affections are discussed.) Cough ought not to be neglected. In some cases its violence threatens to provoke a miscarriage.

DISTURBANCES DUE TO PRESSURE.

Bladder Troubles.—Such disturbances are frequent in the course of the child-carrying period, and specially, as might be expected, towards the end of the period. The bladder is peculiarly apt to be pressed upon, and frequent passing of water, pain in the act, or difficulty in emptying the bladder may be experienced. Dribbling of urine may arise from pressure on the neck of the bladder interfering with its proper emptying, and may be thus the result, not of inability to retain the water, but from the bladder being constantly overfull. A bandage carefully adjusted while the patient is lying down will often relieve such symptoms by the support it affords to the womb. Occasionally the use of a belladonna pessary (see PESSARIES) or the application of hot-water pads relieves irritability. Sometimes the patient will overcome difficulty in making water by changing the position usual in the act of passing water, but sometimes it is necessary to pass the catheter to empty the bladder.

Dropsy, Varicose Veins, and Piles are frequent in pregnancy as the result of pressure, by the enlarging womb, on veins preventing the due return of blood. The feet and legs suffer from the dropsical swelling, and the veins of the inner side of the knee and also of the ankle become swollen and prominent, forming varicose veins (see p. 326). Sometimes the ankle becomes much discoloured, in consequence, as if it had been severely bruised. For these conditions there is no cure. They will in nearly every instance disappear after delivery. Some relief may, however, be given by supporting the womb with a bandage put on as the woman lies on her back, and by supporting the veins of the leg with properly-adjusted bandages. All garters should be discarded, and nothing worn tight round the knee. Elastic stockings, if properly fitted, are very useful. The bowels should be regulated with the Hunyadi mineral water already recommended. Piles often also disappear after delivery. Certainly no operation for their cure should be undertaken during pregnancy. If they are painful, bathing with very hot water gives great relief, and the gall and opium ointment or the tincture of witch-hazel (the American Pond's Extract) may be applied to relieve pain and arrest bleeding. In this case regularity of the bowels is everything.

Dropsy during pregnancy may, however, be the result of an affection of the kidney, termed **albuminuria** (see p. 407). In such a case it affects not the lower limbs merely but the whole body, and is a much graver condition than the dropsy due to mechanical pressure. The legs are greatly swollen and the face puffy. There are also other symptoms, such as headache, dimness of sight, and in severe cases convulsions. The symptoms may, however, not be so serious, and after delivery they may entirely disappear. But a patient who, during pregnancy, suffers from swelling not of the legs only but also of other parts of the body should seek competent advice at once. It is not a condition for which treatment can be definitely laid down here, except that the bowels should be freely opened and kept freely open, at first by a small tea-spoonful of compound jalap powder, and thereafter by daily doses of mineral water, and the diet should be reduced to milk only, six tumblers per day, and the patient kept at rest in bed.

Another form of dropsy, called **dropsy of the amnion**, may be mentioned here. It has been pointed out (p. 625) that the growing child is inclosed within a double sac between the walls of which fluid is contained—the waters. In ordinary circumstances the quantity of fluid would not be more than 2 or 3 pints, but in some cases the quantity is enormously increased. It produces in such cases most excessive enlargement, and is a source of extreme discomfort to the mother, interfering with movement, affecting breathing, &c. It is usually after the middle of pregnancy that the excess shows itself, not much before the fifth month, and it is commoner in twin pregnancies. When the distension is very great the breathing may be so difficult that some treatment is needed. Nature has often afforded relief by the membranes spontaneously rupturing, inducing premature labour. If it were proved necessary, a physician would imitate this procedure. It is not a condition threatening the life of the mother, but it does seriously that of the child.

NERVOUS AFFECTIONS.

These are not uncommon during the child-bearing period. It is quite common for pregnant women to manifest marked alterations in character, an unusual irritability of temper, a tendency to fretfulness, capriciousness, or melancholy, hysterical tendencies also, the woman being easily moved to tears or laughter. Indications of nervous disturbances are also found in perversions of taste, smell, &c. More than this, however, there may be marked signs of mental disturbance, and actual insanity. Convulsions sometimes occur, which may be associated, as mentioned above, with the altered condition of the urine, called albuminuria. As these affections are more common during and after delivery they will be considered later (see p. 680).

MISCARRIAGE AND ABORTION.

These terms are both used to indicate that the offspring has been expelled from the womb before the full period of pregnancy is completed. Abortion is the word which ought to be employed when the expulsion takes place before the eighth month, before the period, that is, when the child has the chance of surviving, and miscarriage is employed after that period, when it is still possible for the child to live. The phrase **premature labour** is still better to indicate the latter state of affairs. There is no doubt that the product of conception is very often expelled from the womb within a few weeks of conception taking place, without the woman being aware of the fact. She thinks her monthly illness has only been delayed. The commonest period for abortion is between the eighth and twelfth week of pregnancy.

The **causes** are very numerous. Accidents, blows, falls, &c., indiscreet exertion in dancing, for example, irritation arising in the bowel from the presence of worms, or the occurrence of diarrhœa, irritation in the genital passage or womb itself, all these may cause it. It may be due also to disease, diseases attended by fever, or any serious disease whatever; it may be the result of a diseased ovum, of tumours connected with the womb, or displacements of the womb. Strong emotion may excite it, and various drugs act on the womb in a way to excite it to expel its contents.

It must be noted also that the womb may readily acquire a habit of expelling its contents at a particular period. If abortion has occurred once or twice about the same time, there will be special danger of the same occurrence about the same time in future pregnancies.

Symptoms.—The chief symptom, to begin with, is pain—pain in the back and in front also If the abortion is very early, the pain may be trifling, but the more advanced the pregnancy the larger will be the mass to be expelled, and the greater the pain. Previous to the pain, a cold uneasy feeling is experienced at the lower part of the belly in front, along with a sense of weight, and the morning sickness and fulness of the breasts may have disappeared. The pain lasts for a time, passes off, and, after a longer or shorter interval, returns. A discharge of blood also appears, which varies in amount in different cases. On the quantity of blood which has been discharged one bases an opinion as to whether or not the threatened abortion can be prevented. If the discharge has been considerable, and repeated, and if the pains keep returning, there is little hope of averting the expulsion of the contents of the uterus. If the pregnancy is advanced to the formation of membranes and fluid, and if the membranes have ruptured and the waters escaped, that is conclusive evidence that the process cannot now be checked.

If any reliable information could be obtained as to whether the offspring were alive or not, that would be a great aid in solving the chief difficulty of the situation. If its death were certain, the expulsive efforts of the womb would be encouraged; if its life were certain, they would be restrained if possible. The feeling of coldness and weight referred to are held as indicating the death of the offspring. Should the pregnancy be advanced beyond the period of quickening, the cessation of all movements on the part of the child would lead to the conclusion that it was dead. This must not be too readily accepted as proof. It has often happened that the movements have ceased for days, till the mother became convinced of the child's death, and yet it has been born alive. In some cases the expulsion of a dead ovum has not taken place for a long time after the death had occurred.

When the abortion or miscarriage actually occurs, the important thing to secure is that everything is expelled from the womb. It is always desirable, in order to make certain that this has occurred, for all clots, &c., to be kept till seen by the medical attendant. In abortion in the earliest months everything is usually expelled together in the form of a fleshy mass, but from the third month there is greater liability of something being retained, which will lead to subsequent trouble. After the sixth month the miscarriage becomes similar to labour at full time, but more easily accomplished.

Treatment.—The first and most essential part of treatment is rest, complete rest in bed, the patient lying flat, with head low. If the abortion or miscarriage is only threatened, this is the first and chief means to ward it off. Unstimulating light diet is to be given, and always cold. If pain is the chief symptom, an opiate is very valuable, say 20 drops of laudanum, which would be best given mixed with a teacupful of thickish starch as an injection into the bowel. If a discharge of blood is the chief symptom, acid drinks and a lead and opium pill is advised. Repeated doses of opiates should, however, never be given without medical orders. If the abortion is arrested, rest must be continued for a prolonged period, and great care exercised. If such treatment does not arrest the expulsive action, if the pains are returning at regular intervals in strength, and the discharge of blood is considerable, and certainly if the waters have come away, other treatment, designed to aid the process, is needed. For this purpose from a half to a tea-spoonful of liquid extract of ergot is given every third hour till everything is expelled.

A woman who has miscarried or aborted must be treated in every way as one who has been delivered at the full time, and must be allowed as long a period of rest in bed afterwards. Further, such an one must remember that she runs special risks of repeating the same performance at a similar period of a later pregnancy, and must, therefore, take special precautions about such a time, avoiding undue exertion and fatigue, and, it is specially to be noticed, *avoiding all sexual excitement.*

FLOODING.

This is the ordinary term applied to profuse loss of blood from the pregnant womb. It may occur either before the period of confinement or afterwards. Of course loss of blood occurs in abortion, but it is attended usually by the pains, which indicate what is going on.

Flooding Before Delivery. — Alarming losses of blood occur within the last three months of pregnancy, due to the placenta, or after-birth, occupying a peculiar position in the womb. This is called properly **placenta previa.** The after-birth is situated partially or wholly over the passage, through which during delivery the child must pass, and therefore it is separated either wholly or partially some time before the birth can occur. By this separation blood-vessels are opened, and the womb not being able, owing to its contents, to contract and close the bleeding vessels, a great loss of blood occurs very speedily. The actual determination of this condition can only be made by a medical man after a careful examination; but a profuse loss of blood occurring within the last three months of pregnancy, without any apparent cause, should cause a woman to seek immediate skilled advice. Sometimes there is no sign of this condition till the full time, after labour has set in, and then the loss of blood may be immediately so great that the life of the mother is threatened before any assistance can be obtained.

Treatment. — Medical aid cannot be dispensed with. All that others can do is to put the patient to rest on a hard bed, with low head, and to give low diet, cold, all stimulants being avoided. If the loss of blood is great and danger threatening before aid can arrive, attempts may be made to stop the flow of blood by plugging the passage. This is to be done by pushing up strips of lint one after another, or pieces of a silk handkerchief, till the whole passage is thoroughly packed. Tea-spoonful doses of the liquid extract of ergot may also be given in cold water every third hour.

Flooding After Delivery will readily occur if the after-birth has not been expelled. It also occurs, when everything has gone on satisfactorily, the after-birth has been removed, and all has seemed well, owing to the womb relaxing, because of want of vigour, and permitting the torn vessels again to open and pour out blood.

The **symptoms** are not only the visible flow of blood, but the patient complains of faintness or dim sight; she is white and cold, with clammy skin.

In the former case the after-birth must be got rid of. A medical man would probably pass up his hand into the womb and remove it. In the absence of such assistance let a large dose of the liquid extract of ergot be given, one to two tea-spoonfuls. Let someone place the *cold* hand over the lower part of the woman's belly and rub, with the design of exciting the womb to contract. Cold water may be dashed over the belly and cold water injected into the genital passage by an enema syringe.

Similar treatment is to be adopted if the bleeding occurs after the after-birth has been removed.

MOLAR PREGNANCY OR BLIGHTED OVUM.

Flesh-mole.—Sometimes the product of conception dies without abortion speedily occurring. Owing to some part of it remaining connected with the womb, growth goes on, the membranes undergoing thickening and degeneration. This may continue till at length a fleshy mass is discharged, called the **flesh-mole.**

Vesicular Mole.—In other cases one of the membranes undergoes a peculiar development, so that a mass is produced resembling a bunch of currants, when seen floating in water coloured with some of the discharged blood, like a mass of "white currants in red currant juice." This is the **vesicular mole.**

Symptoms.—In each case the woman usually suspects something is wrong. The usual symptoms of pregnancy are experienced for a time, but the enlargement of the belly is much more rapid than usual. In the case of the fleshy mole, the growth is so rapid that at the end of the third month the enlargement is as great as is customary at the end of the fifth. In the case of the vesicular mole the normal symptoms go on till about the third month, and then enlargement becomes very rapid, and is more towards the side than upwards. The other usual symptoms are indistinct, the patient feels differently from what she did in other pregnancies. Watery discharges, mixed with blood, may occur, and the feelings of movement of the child are not experienced.

The mole is usually expelled after six months. It has sometimes occurred in twin pregnancy that one of the ova has undergone such degeneration, and the other has followed a normal development, so that at the sixth month a living child has occupied the womb along with a vesicular mole. In such a case the danger is that the expulsive efforts of the womb do not end with ridding it of the mole, but go on to the expulsion of the fœtus at a time when it cannot survive. Some cases are recorded, however, in which the mole was expelled, and a healthy living child was born at the full time.

Treatment of such cases rests, of course, with a physician. In any case where such cannot be obtained soon, and there is considerable watery and bloody discharge, especially if some of the currant-like material has been expelled and shows clearly the nature of the case, error can hardly be committed by giving full doses (tea-spoonful) of the liquid extract of ergot of rye, every two or three hours, as long as seems necessary to restrain loss of blood.

OTHER DISEASES DURING PREGNANCY.

The pregnant woman may, of course, be attacked by various ailments, like any other woman—lung affections, such as bronchitis, pneumonia, heart disease, kidney disease, infectious disease, and so on.

These diseases are recognized by the signs and symptoms detailed in their appropriate place in this book.

It is only necessary to say here that they may become very serious complications to the pregnant state, and may occasion miscarriage or the death of the child. Exceptional care should, therefore, be taken by the pregnant woman not to delay obtaining medical assistance for even slight ailments, or at least to take special care of herself during the most trifling ailments. In all cases there are three things to attend to as prudent precautions:

(1) To secure a day or two of rest in bed;
(2) To reduce the diet to simple milk, with bread and butter, milk pudding, &c.; and
(3) To obtain a gentle but complete clearing out of the bowel.

Lung Affections have been sufficiently referred to under Disturbances of Breathing (p. 671).

Heart Affections (see p. 318).—It may be remarked here as a notable fact that a degree of hypertrophy of the heart occurs in the pregnant state normally, and is frequently a singular help to women with weak heart or valve disease during the child-carrying period and the strain of delivery.

Kidney Affections are sufficiently alluded to on p. 672.

Urinary Disturbances are referred to on p. 671.

Infectious Disease is a very grave complication of pregnancy and the period following child-birth, specially in the form of scarlet fever or typhoid fever. It is also noteworthy that a woman may become infected with one or other of these diseases towards the end of the pregnancy, but no symptoms may appear till after the birth of the child, after which they may set in with great rapidity and violence. It is at first difficult to distinguish, in such circumstances, between them and puerperal fever.

DIFFICULTIES DURING LABOUR.

PROTRACTED LABOUR.

It has been pointed out that labour is a natural process, and that in the vast majority of cases it pursues a regular course, with which interference is undesirable and often harmful.

Delay, causing protracted labour, may be due in general to one of these causes: (1) to lack of expulsive effort on the part of the womb; (2) to excessive narrowness or rigidity of the canal through which the child has to pass; or (3) to an abnormally large child, or an unusual position of the child. Some of these causes may come into play earlier in the labour than others. Thus, at the outset the expulsive effort may be sufficient, but it may give out in the later stages; and, again, everything may go on normally till the child's head is at the outlet, and there it may, by excessive smallness of the outlet or rigidity of the parts, be arrested for a long time, till the woman becomes utterly tired out with her efforts.

It would be profitless to discuss, in a book such as this, all the various causes of protracted labour, the means of distinguishing them, and the measures taken to overcome them, for all these require the attention of a trained medical person, and ought not to be dealt with by a mere nurse or midwife. But it may nevertheless be prudent to give some indication of what a nurse or midwife might do, supposing medical assistance to be far off or long delayed.

The various stages of labour have been described on pp. 637–642, and we shall note some of the more frequent causes of delay operating during the various stages.

Delay during the First Stage.—This is the stage in which the mouth of the womb is opening—dilating. It has been pointed out that a main agent in the dilating of the mouth of the womb is the pressure of the bag of membranes insinuating itself between the lips of the womb with each pain. If the membranes have ruptured early in labour, this agent is lost or greatly diminished. If, therefore, a free escape of water occurs when labour should be beginning, or soon after it has begun, the woman should take to bed to avoid, in the horizontal position, the loss of water as much as possible. Delay at this stage is sometimes due to rigidity of the mouth and neck of the womb. This is more likely to occur in women who are pregnant for the first time after thirty years of age. It may be also due to irregular contractions of the womb, and to a spasmodic contraction of the mouth, simultaneous with the expulsive effort of the rest of the organ. This cause is easily overcome by the patient being put under the influence of chloroform. This, of course, can only be done by a qualified person, but a dose of chloral hydrate is also very useful, and 10 grains in water might be given, and repeated every half-hour till a total of 30 grains had been given. This should only be given, however, if a long time of ineffective severe pains had elapsed, and an examination with the finger had shown the lips of the womb to be hard, dry, hot, and unyielding.

Delay in this stage by lack of power of the contractions of the womb is generally recognized by the shortness of the pains, the little evidence of suffering on the part of the patient, and the lack of firmness of the womb when the hand is laid on the belly during a pain. Such **uterine inertia**, as it is called, is frequently due to the nervous state of the patient, and is not infrequently caused by the presence in the lying-in room of some person whom the patient would rather not have there. In such cases it would be better that only the nurse should be in the room. A very hot drink often sets the contractions going more vigorously, and a mild stimulant like a glass of sherry sipped slowly, along with a biscuit, is frequently of great value.

Delay from this cause is sometimes due to a pendulous belly, hindering the pains pressing the contents directly on to the mouth of the womb. This will be overcome by the pressure of a well-adjusted binder.

Sometimes also an excess of waters, by over-distending the womb, causes ineffective pains. Rupture of the membranes is the remedy for this condition, but no midwife or nurse should lightly adopt this procedure. It has been pointed out (p. 641) that frequently the womb sinks down on to the pelvis even three weeks before the due end of pregnancy, and this falling down, by the pressure exerted on soft parts, often sets agoing pains quite like labour pains. **False pains** they are called. In many cases a single dose of a sedative will allay them. But they frequently go on, intermittently, for many hours. A hasty nurse, mistaking these for real pains, getting impatient at the failure to progress, and deciding to rupture the membranes, would commit a grave error of judgment, which might be paid for by the child's life. For so long as the membranes are entire, and the waters surround the child, it is safe.

Whatever may be the cause of delay in the first stage, drugs for increasing the vigour of the uterine contractions must never be used by any non-medical person. In particular, ergot must never be employed.

Delay in the Second Stage may also be due to failure in the contractions of the womb to force the child on, or to narrowness or loss of elasticity of the passages, or to blocking of the passages by some obstruction, or to the size or position of the child. This is the stage beginning when the mouth of the womb is fully dilated and ending with the birth of the child.

Now, when the mouth of the womb is fully dilated, it is possible for the trained person to determine by finger examination the part of the child which is coming first, and also what relation that part bears to the canal through which it must pass. Thus the finger can not only ascertain whether the child is advancing head first, but also in which of the four positions noted on p. 639 the head is placed. But at this time the child is not yet engaged in the birth-canal, it is only about to enter the canal. If there is anything irregular in the presentation—the part of the child that is in advance,—if, for instance, the child is lying across the mouth of the womb and a shoulder is presenting, this is the time when a little manipulation can easily rectify it. By this time, also, a competent medical man would have ascertained that there was no undue narrowing of the passage and no obstacle to the gradual progress of the child along it. These circumstances make it clear that, if possible, nothing should be permitted to stand in the way of a woman having, at the very least, the advice of a medical man early in her labour.

When the mouth of the womb has been fully dilated, the bag of waters ceases to be of any further value. If the membranes remain unruptured, the retained waters only hinder the advancing part of the child coming into contact with the walls of the canal, and so hinder progress. In the second stage of labour, therefore, unruptured membranes are as much a hindrance as in the first stage they are a help. Sometimes, therefore, in the second stage of labour rupturing the membranes is all that is required to hasten delivery.

It would be quite profitless to consider here causes of delay due to narrowness of the passages of the mother or exceptional size of the child. The remedy for the most of these conditions is some form or another of operative interference.

Allusion must, however, be made to two conditions, the subjects of the immediately following paragraphs.

Cross-Birth.—If the fact of a transverse presentation, as cross-birth is technically called, has not been recognized sooner, it usually becomes evident by the descent of a hand. Any such occurrence in a case in charge of a nurse only, or midwife, should lead to the immediate summoning of a doctor.

From the hand there can be ascertained the position of the child's head, for when the hand is outstretched the thumb points to the direction of the head of the child in the womb. This enables the surgeon to pass his hand into the womb in the direction in which lie the feet of the child, the child being delivered by bringing down a foot, and so causing the child to turn in the womb. This manœuvre may be impossible, if so much delay has been permitted to occur as to cause the child to be jammed tight in the birth-canal.

Contracted Pelvis of the Mother is a frequent cause of delay in the second stage, and may render the delivery in the ordinary way impossible. This deformity in the mother may be due to rickets, and the fact of rickets will be probably evident from other signs (refer to p. 71). The effect of this deformity on the pelvis is to produce a thrusting forwards of the sacrum, diminishing the diameter of the pelvis from before backwards, and producing what is called a **flat pelvis**. This may be roughly illustrated by taking a circular metal ring, and pressing upon it; its circular shape is destroyed, and while the diameter in one direction is increased, in the other it is diminished—the ring is flattened. Such a deformity of the pelvis alters the whole mechanism of labour, and, if it be excessive, the strait through which the child ought to pass may be so narrowed as to make it impossible. Any woman who has clearly suffered from rickets ought not to run the risk of pregnancy before making certain that in her case natural delivery is possible.

Flat pelvis may, however, exist apart from rickets, and there may be nothing to indicate the condition till the difficulty occurs in labour.

DISEASES AFTER CHILD-BIRTH.

HÆMORRHAGE.

Flooding (*Hæmorrhage*) has already been sufficiently discussed in the previous paragraphs (p. 674).

AFFECTIONS OF THE BREAST: THE MILK SUPPLY.

Cracks and Fissures of the Nipples are a common cause of much suffering after child-birth. These are to be avoided by regular nursing, by carefully bathing the nipples after each nursing with cold water and drying them, and by the use of some agent which will toughen the skin, of which the best is glycerine of tannin, or glycerine of borax. It is not a matter of wonder if a mother suffers from tender nipples who permits her child to be continually at the breast, so that one nipple or another is constantly in the child's mouth. Some mothers suffer from such an excessive flow of milk that the dress is continually wet and the breast continually in a milk-bath. This will naturally make the skin tender and readily crack. Keeping the breasts as dry as possible, and limiting the flow of milk, if possible, by dieting, are the remedies. If the nipples are hacked and painful, the use of a nipple shield during nursing gives much relief, the other treatment already indicated being employed.

It is needful to bathe off, with cold water, the tannin and glycerine or other application before putting the child to the breast.

Abscess or "Gathered Breast" often results from neglected cracks and painful nipples. The breast becomes full and swollen and painful, especially over one part, which also becomes hard. The breast should be treated as recommended under milk-fever, first with the iced-water, and then, if it fails, with hot water applications. A brisk dose of opening medicine (seidlitz-powder) should be given. If matter forms, it must be "let out" by the abscess being opened, and should on no account be allowed to burst.

Whenever the breasts are large and swollen, great relief is given by a bandage passing under the affected breast and over the opposite shoulder, so as to support it.

It is also necessary to keep down the swelling of the breasts as much as possible by regular removal of the milk. If this is not properly done by the child, a breast-exhauster, or breast-pump, must be secured at once, and the milk must be frequently drawn off by its means. The exhauster and its mode of application are shown in Plate XXXI. It is advisable to apply the exhauster every two hours or so, to remove by its means small quantities of milk frequently rather than to attempt to remove a large quantity at one time. If this is done, and the other measures advised are adopted, threatened inflammation of the breasts will often be speedily subdued.

Defective Supply of Milk.—This is sometimes due, during the first few days of nursing, to the mother's own anxiety lest she should not have enough milk for her child, the anxiety acting as a hindrance to the milk production by nervous influence. Good nourishing food, with a plentiful supply of liquids, specially hot milk, and at the same time such measures as are likely to stimulate the breast, such as friction with warm oil, are almost certain to overcome the difficulty, along with perfect regularity in putting the child to the breast.

Excessive Supply of Milk is met by opposite measures, a dry diet, at longer intervals, and support and gentle pressure over the breasts by a firm bandage. The bandage should be broad enough to cover the whole breast, and a small opening on each side should permit the nipple of each side to pass through. If this is insufficient, the whole breast may be painted, except the circle round the nipple, with extract of belladonna, made thin enough with glycerine; a square of gamgee, with a sufficiently large opening in the centre, is then put on and firmly secured by means of the broad bandage.

To Stop the Production of Milk, the measures noted in the immediately preceding paragraph should be taken. In addition, of course, the child would not be put to the breast, except to draw just sufficient to relieve the mother, though a breast-exhauster would be best for this purpose. Also a brisk dose of saline medicine—seidlitz, effervescing saline, Hunyadi Janos water, or Epsom or Glauber's salts—should be given. If these steps are insufficient, a dose of 10 grains iodide of potassium, given in a wine-glassful of water, and repeated every six or twelve hours for three or four doses will probably be effectual.

IRREGULARITIES OF THE DISCHARGE AND BLADDER TROUBLES.

The Discharge or Lochia should continue for from two to six weeks after child-birth. For the first four days it is abundant and red, with clots. During the next two or three days the discharge should become less and distinctly paler and thinner. After six or seven days it should be yellowish and scanty. It should never be foul-smelling. It is usually less after the first than after succeeding pregnancies, and should never blanch the patient. If it continues in large quantity at the beginning, causing the mother to become faint, and dizzy, and white, there is something wrong, requiring immediate medical care. The retention of membranes or part of the after-birth may be the cause, as already noted on p. 674. In the absence of medical aid, a tea-spoonful of liquid extract of ergot in a tea-spoonful of whisky with water may be given at once, and the abdomen over the uterus may be kneaded to provoke better contraction of the womb. If the discharge becomes fœtid, a douche should be given by enema or douche, as described on p. 659. This should daily be repeated till the odour quite disappears, and scrupulous cleanliness of the external parts, bed and body clothing, is necessary.

The bladder frequently gives trouble after a prolonged or difficult labour, the commonest occurrence being difficulty in passing water. This has been discussed on pp. 656, 668.

FEVER AFTER CHILD-BIRTH

Milk Fever.—On the third day after delivery the rush of milk to the breasts becomes usually very marked, and is frequently attended by considerable disturbance, feverishness, quick pulse, and headache. The breasts are very full, and may be hard, and markedly knotted and painful. This is the condition called **milk fever**, and also called popularly a **weed**. If care has been exercised all through the period of delivery and after it, and everything has been scrupulously clean, if also the directions given on p. 646 have been followed, and in particular if the child has been regularly put to the breast every third hour (see p. 560), the chances of such a condition arising are extremely small.

Treatment.—Give a strong dose of opening medicine, a double-strong seidlitz-powder being preferred, or a full ounce of castor-oil. Put the child regularly to the breast every 2½ hours. If, owing to the swelling of the breast, the nipple is below the level of the breast, let it be pulled out by means of a breast-exhauster; and if the child cannot empty the breast, let the breast-exhauster be used as well. It is necessary to keep down the swelling in every way possible. Much relief will be given by laying over the breasts a soft handkerchief soaked with ice-cold water. This may be renewed every quarter of an hour or so, if it is giving relief, but care must be taken not to overdo this, and not to permit the mother's clothing to become wet in the process. Warm applications, in some cases, are advised, but are to be used at first with caution. The cooling application should first be tried. If the breasts are knotted, gentle light rubbing with oils aids their relief. Meantime liquids must be given to the mother sparingly, and more solid food given. She may suck a small piece of ice to relieve thirst.

If, within a very few hours, these measures have not given relief, 10 grains of Dover's powder may be given in water, *but not until the bowels have been freely opened.* A second may be given in four hours, and, if it seems useful, a third six hours after the second, but no more without advice. The bowels will probably require to be opened again by medicine, as the powders have a binding effect.

Puerperal Fever (*Child-bed Fever*).—This is one of the most appalling diseases that may follow child-birth. In most cases it is fatal within a very short period, ten days or so after delivery. It may be regarded as due to the passage into the blood of some poisonous material, probably of the nature of a living organism, such as has been discussed in Section XXIV., which multiplies in the patient's body, and produces by its activity all the symptoms of the disease. (See SEPTICÆMIA, p. 315.) The poisonous material may come (1) from the patient herself, or (2) may be introduced from without by, unhappily it is so, the doctor, the midwife, the nurse, or other attendant, or (3) as contagion from some other disease. Thus, to take examples, a patient may have had a miscarriage, the whole of the after-birth, membranes, &c., may not have come away. The retained portions may undergo changes of decomposition in the womb. Suppose now the woman again becomes pregnant. After delivery some of this decomposed material may pass into the blood and occasion the fever. Or a similar thing may occur at an ordinary confinement, fragments of the after-birth may remain behind, undergo putrefaction, and occasion the disease. Thus the woman may infect herself. A medical man may convey the disease by attending a confinement after assisting at a *post-mortem*, or after dressing foul wounds, &c. Similarly it may be occasioned by the use of unclean instruments, sponges, syringes, &c. An example of the third means of communication is afforded by erysipelas and scarlet fever. These diseases attacking a woman, recently confined, assume extremely violent and fatal characters, due to the peculiar condition in which necessarily the woman happens at that time to be.

Puerperal fever is a contagious disease. The danger of it being carried from one suffering from it to another patient in the process of confinement is enormous. No conscientious medical man will go from a case of puerperal fever to attend another confinement case without previously taking the greatest precautions against carrying the disease with him.

The disease, it will thus be understood, does not assume necessarily the same form in each case. In one apparently the poison is absorbed in a very fine form, and multiplying in the blood produces violent fever, diarrhœa, delirium, &c. In others it is absorbed, as it would seem, by the mouths of the open veins of the womb, in the form of larger particles, which, being carried with the blood current through the body, are arrested in various places, and form small abscesses. In such cases little abscesses may be visible on the skin, on the fingers, &c. In other cases the disease is in the form of an acute inflammation within the belly, as peritonitis (see p. 265), or as inflammation of the womb itself. Inflammation of the lungs and other organs may speedily arise in the course of the disease, due, doubtless, to the conveyance to these organs of some of the poisonous material.

Symptoms.—All of the various forms cannot be described, but we may state in some detail the characters of the fever in general. It begins usually within three or four days after delivery, perhaps with a shivering fit (rigor), headache, and depression. The fever soon runs up to a considerable height, 103° or more by the thermometer (see p. 38). The pulse is rapid and feeble, the skin dry as well as hot; sometimes there is much sweating, and the sweat has a peculiar odour. The discharge from the genitals may cease; sometimes it does not, and the discharge is foul-smelling. The formation of milk is usually arrested. The bowels are loose, and the motion very offensive. The tongue becomes brown and dry, and little brown masses (*sordes*) form on the lips. Vomiting is frequent, the vomit being offensive. There is usually some amount of pain in the belly, which may become much swollen, adding to the distress. If muttering delirium sets in, and the patient's hands wander about picking at the bed-clothes, the case is as grave as can be. A very hurried feeble pulse, and rapid panting breathing, indicate sinking from exhaustion.

In other cases, at the very beginning of the fever, the patient complains of acute pain in one spot, usually low down in the belly, and the pain is apt rapidly to extend over the whole belly, which becomes much swollen, and is so painful that the mere weight of the clothes is distressing. To obtain some relief the patient lies on her back, with her knees drawn up. In such a case, instead of the bowels being loose, they are usually obstinately costive. Later on severe looseness of bowels sets in.

Treatment is too often utterly in vain. But if everyone were scrupulously careful cases of this disease ought to become exceedingly rare.

Moreover, the variety of the disease is so great that no one method of treatment is suited for each case. While stating this very strongly, we may even in such a very serious disease go on the same principle that pervades this book, and indicate general lines of treatment that may be adopted by any unfortunate enough to have no medical aid within reach. It is best to begin by clearing out the bowels with a large injection of tepid water, 3 or 4 pints. Nourishing food and stimulants must be freely given. Milk, eggs, nourishing soups, such as mutton soup, beef-tea, hough soup, &c., should be given in small quantities often, unless very loose bowels prevent much use of soups. Their loosening effect on the bowels may be to some extent checked by thickening them somewhat with corn-flour, &c. Whisky or brandy should be given in small quantities with milk to the extent of 3 or 4 ounces (one to two wine-glassfuls) per day, if it seems to agree. Port wine is also useful, and champagne. The fever is somewhat held in check by large doses of quinine, 10 to 15 grains every fourth or sixth hour; and to this may be added 10 grains of Dover's powder, if it seems to agree with the patient. If there is pain in the belly, a thick pad of flannel should be lightly wrung out of hot water, sprinkled with turpentine, and laid over the belly. This is kept on and repeated till the whole surface is red. If discharges from the genitals are fœtid, injections must be used with an enema syringe, fitted with a long delivery-tube. Water, rendered pink with Condy's fluid, is employed to the extent of 2 or 3 pints, or carbolic acid solution of a strength of 1 ounce of the acid to 2 pints of water. This injection may be repeated twice daily. Great care must be taken that the injected fluid escapes freely. The patient's room must be freely but carefully ventilated.

NERVOUS AFFECTIONS AFTER CHILD-BIRTH.

Convulsions occurring during pregnancy or labour, or after child-birth, are of very serious meaning. They are commonly due to the condition known as albuminuria (see pp. 407 and 672), although they may occur without such a condition, caused, as some believe, by a too watery condition of the blood inducing a state of bloodlessness (ANÆMIA, p. 313) of the nerve centre.

Symptoms.—Convulsions may occur without any warning, but usually warning of the coming attack is given by the occurrence of headache, usually of the front of the head, of a very intense kind, and likely to be continuous when the fit is near at hand. Another warning sign is derangement of vision, dimness or cloudiness of sight, or some other disturbance of clearness of sight. In a few cases severe pain is felt over the pit of the stomach. One sign which ought not to be disregarded is puffiness of the face, and swelling of the ankles, feet, and external genital organs. Such a condition ought to lead to immediate medical advice. The fit itself is of a marked kind. The eyes are fixed, within a few seconds the face and eyelids are spasmodically twitched, the eyeballs roll, and the face is pulled down first to one shoulder and then to the other, the mouth being also twisted, and the upturned eyes show only the white part of the ball. The convulsive movement then passes quickly over the rest of the body, and for a little the whole body is stiff, head being bent back, limbs stretched out, and hands clenched. After a brief period, irregular spasmodic movements occur of great violence. The face is violently twitched, the arms jerked, the tongue is often caught between the teeth and severely bitten, and froth mixed with blood from the tongue escapes from the mouth. Breathing is suspended till the face becomes purple. Motions from the bowels and water from the bladder are often passed. All this time there is complete loss of feeling and consciousness. As the fit passes off the spasms become less, the movements gradually cease, breathing becomes natural, and the face loses the purplish hue, and consciousness may be soon restored, or the patient may lie in a heavy torpor for some hours. When consciousness is restored the patient complains probably of headache and a dull stupid feeling. One attack may succeed another, consciousness not returning in the intervals, or there may be but one attack altogether.

The more severe and prolonged the attack, and the more frequent its recurrence, the graver is the case, though the author has seen one attack follow another for a couple of hours, and recovery take place. One in every three or four cases proves fatal.

If the convulsions occur before labour has set in they are extremely likely to provoke labour, and thus the life of the child is threatened. When labour is brought on it is often accomplished with great rapidity. The birth of the child has, however, a tendency to lessen the severity of the attack.

Treatment.—Very little can be done by an unskilled person. A medical man would probably administer chloroform, and if labour had begun would, if possible, effect delivery. Harm would not be done if, when medical aid was not obtainable, a draught containing 30 grains bromide of potassium and 10 grains of chloral hydrate, dissolved in water and simple syrup, were given immediately after one attack to prevent, if possible, a second. The dose could be repeated every two hours for four doses.

Insanity may occur during the child-bearing period, during labour, or after delivery. It is most common in those with child for the first time, and in many there is an inherited tendency. In cases occurring during the child-carrying period, or after delivery, the commonest form is melancholia, evidenced by great depression of spirits and delusions, and when the case is a severe one there is a tendency to suicide. These cases are more apt to occur in weakly, ill-nourished women, or those who have been much reduced by frequent pregnancies, prolonged nursing, or intemperance. Insanity during the progress of labour is frequently in the form of maniacal excitement, occurring during the most painful part of the process. The attack of mania may also occur some time after delivery, within a week or ten days, and occurs suddenly, or after a period of sleeplessness. There is considerable fever, small throbbing pulse, and bright eyes. The patient regards her attendants with suspicion. She talks excitedly, and the talk passes into raving, and she may attempt her own or her child's life. There is great sleeplessness, and the milk and discharge cease. Digestion is very seriously disturbed, the urine is high-coloured and scanty, and the bowels usually costive, though they may be loose. Recovery occurs in nearly three-fourths of the cases, that from mania may be within three or four weeks. Melancholia is less threatening to life but more to reason. It may last from a few weeks to a year or more, but most of the recoveries occur within six months.

Treatment.—Mania occurring during labour is met by chloroform. If it occurs afterwards the bowels should be unloaded by means of a simple injection of warm water and soap, and 20-grain doses of bromide of potassium in water may be given every four hours. But such cases are too serious and demand too much skill and care to be treated by any but qualified persons. The melancholic form needs, above all, careful dieting and quietness, freedom from worry and annoyance, kindly and watchful attendance, which had better be given by strangers than by the patient's own friends. A woman who thus suffers, or has suffered, should not attempt to nurse her child.

STERILITY.

Sterility is want of the power of reproducing offspring, and is to be distinguished from impotence, which means inability for sexual intercourse. Sterility is not necessarily the fault of the wife. It may also be due to defect in the husband. In all cases it is desirable that this should not be overlooked, though here only sterility in the female will be considered.

In the first place, it may be that the sexual act is not duly performed. This is more frequent than might be supposed, for neither husband nor wife cares to consult even the medical attendant, when the act of intercourse is attended with difficulty. Such a condition is called **dyspareunia**. Sometimes the genital passage of the female is so narrow, either naturally or as the result of inflammatory contraction, as to cause the difficulty, or the presence of painful spots or excrescences renders the act so painful that it is discontinued. The writer has treated such cases, in which this condition had existed for years without any remedy being sought, because of the idea that relief could not be obtained. It should, therefore, be plainly stated that this idea is in many cases erroneous, and that often a cure is easy of accomplishment, involving no severe or heroic method of treatment. Supposing, however, the sexual act to be duly performed, and supposing no defect to exist in the husband, the intercourse may be barren, from a variety of causes. The cause may lie in the ovaries (p. 619), where the ova are developed, or in the tubes (fallopian tubes, p. 619), down which the ova should be conducted to the womb, or in the womb itself, or in the genital passage.

In rare cases the ovaries are absent or imperfectly developed, and do not perform their function of producing the female element in the reproductive act. It may be that the ovaries have been mature, but have been destroyed by inflammatory or other disease. In some cases the ovaries are displaced, and the ova are ripened but do not find their way to the fallopian tubes. Inflammation may have blocked the tubes so that the ova cannot pass down to the womb.

Again, the fault may exist in the womb, which, in very rare cases, is altogether absent or has never grown to maturity.

More commonly displacement or inflammation of the womb is a cause of sterility, the displacement preventing the due meeting of the male and female element in conception, and inflammation rendering the womb unfit for its duty of receiving and retaining an ovum which has undergone the changes of conception. In many cases the discharge from a womb that is the seat of such a disease is destructive to the life of the male element, and conception is thus prevented.

In other cases of sterility tumours of the womb are the cause. Sometimes the cause is a very contracted state of the mouth and neck of the womb preventing the passing upwards of the fluid from the male.

An inflammatory condition of the genital passage, specially such as is attended by a profuse discharge, produces sterility by the injurious effect of the discharge on the semen from the male.

Treatment in each case depends on the cause of the failure. Displaced and inflammatory conditions of the womb, as well as contracted states of the neck and mouth of the womb, &c., are all open to treatment, and the treatment in many cases is attended by the desired result. But women ought to be warned to trust only the opinion and advice of well-informed and conscientious physicians.

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THE HUMAN BODY.

DISSECTION OF THE CHEST AND CONTENTS OF THE CHEST CAVITY.

1 represents the skin surface before dissection.

2 shows what is seen when the skin and underlying fat have been removed, namely, the great muscles of the chest wall.

3 is a representation of what is revealed when the chest wall down to the ribs and upper part of the abdominal wall have been removed. The figure is placed on the breast-bone, and the ribs and intercostal muscles are seen, as well as the contents of the upper part of the abdomen.

4 is the upper lobe of the right lung,

4A is placed on the middle lobe,

4B is placed on the lower lobe.

5 is the upper lobe of the left lung, 5A the lower lobe.

6 is placed on the left ventricle of the heart,

7 is on the left auricle of the heart.

8 is the arch of the aorta, and 9 on its branches to the head and neck.

10 is placed on the great veins going to the right side of the heart from the head and neck.

11 represents what is seen when the lung is cut into. The figure is placed near branches of the main bronchial tubes.

12 is on the diaphragm.

13 is on the liver, and 14 on the stomach.

H is on the larynx, and K on the thyroid gland.

The parts marked 1, 2, 3 speak for themselves. It will be observed that when the front wall of the chest is dissected off down to the bones, and the dissection carried so as to include the upper part of the abdominal wall, that the liver and stomach are seen to lie more or less under cover of the ribs, the liver lying mainly to the right side, but projecting beyond the middle line to the left, so that a finger pressed on the abdominal wall just at the end of the breast-bone would press on the liver.

When the whole bony wall of the chest has been removed (represented by lifting the flap 3) it is seen that the lungs occupy the main portion of the chest cavity, the heart lying between, largely overlapped by the lungs, specially the left, and that the heart lies obliquely, its apex being directed to the left side. The position of the great artery arising from the heart and the great veins passing to it, and the branches of these to head and neck and upper limbs, are well shown. The plate also shows how the diaphragm separates the cavity of the chest from that of the abdomen, and how the liver and stomach lie under cover of the diaphragm. The lower part of this plate just indicates the transverse portion of the large bowel below the liver and lower border of the stomach. The plate representing the dissection of the abdomen shows this more fully.

For full information regarding the Apparatus of the Circulation, see page 213.

THE HUMAN BODY.

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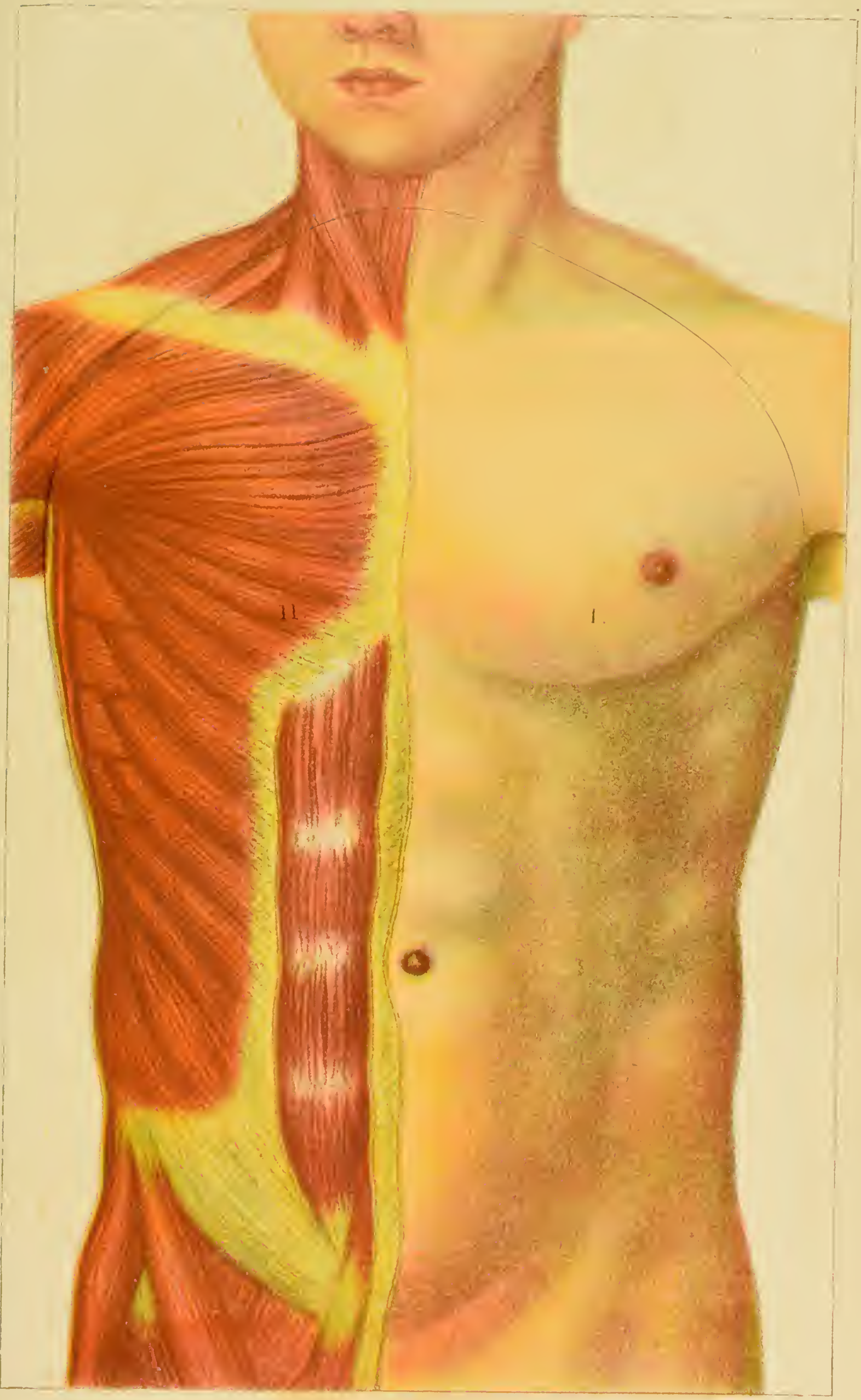

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13 is on the liver, and 14 on the stomach.

H is on the larynx, and K on the thyroid gland.

The parts marked 1, 2, 3 speak for themselves. It will be observed that when the front wall of the chest is dissected off down to the bones, and the dissection carried so as to include the upper part of the abdominal wall, that the liver and stomach are seen to lie more or less under cover of the ribs, the liver lying mainly to the right side, but projecting beyond the middle line to the left, so that a finger pressed on the abdominal wall just at the end of the breast-bone would press on the liver.

When the whole bony wall of the chest has been removed (represented by lifting the flap 3) it is seen that the lungs occupy the main portion of the chest cavity, the heart lying between, largely overlapped by the lungs, specially the left, and that the heart lies obliquely, its apex being directed to the left side. The position of the great artery arising from the heart and the great veins passing to it, and the branches of these to head and neck and upper limbs, are well shown. The plate also shows how the diaphragm separates the cavity of the chest from that of the abdomen, and how the liver and stomach lie under cover of the diaphragm. The lower part of this plate just indicates the transverse portion of the large bowel below the liver and lower border of the stomach. The plate representing the dissection of the abdomen shows this more fully.

For full information regarding the Apparatus of the Circulation, see page 218.

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DISSECTION OF THE ABDOMEN AND ITS CONTENTS